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DIGITAL HIVE PROJECT: PROTOTYPING A COLLABORATIVE WEB PORTAL FOR THE EXPLOSIVE ORDNANCE DISPOSAL COMMUNITY

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Information is currently being produced at a volume and velocity that surpasses the ability of individuals to make full use of it within a given time constraint—a condition known as information overload. Advances in technology, namely the Internet, have exacerbated information overload at all military commands. At the operational level especially, leaders are unable to receive adequate timely information necessary for complex problem solving and decision making. Thus, they satisfice with the limited time and modicum of information they have when making important decisions. The issue addressed in this capstone project is how the explosive ordnance disposal (EOD) community can cope with information overload, especially in complex and turbulent environments when up-to-date information is critical to its mission success.

Using a design methodology, members of the EOD community developed a Web 2.0 prototype website to aid in the processing and management of information. The results to date suggest great potential for improving information processing and management when using the website.

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DIGITAL HIVE PROJECT: PROTOTYPING A COLLABORATIVE WEB PORTAL FOR THE EXPLOSIVE ORDNANCE DISPOSAL COMMUNITY

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LIST OF ACRONYMS AND ABBREVIATIONS

AEODPS	Automated Explosive Ordnance Disposal Publication System
AFRCICOM	United States Africa Command
ASM	Advanced Skills Management
ATF CES	alcohol, tobacco and firearms certified explosive specialist
CIA SPS	Central Intelligence Agency Security Protective Services
CIDNE	Combined Information Data Network Exchange
CSG	carrier strike group
DCGS	distributed common ground System
DRRS-N	Defense Readiness Reporting System-Navy
EOD	explosive ordnance disposal
FBI SABT	Federal Bureau of Investigation Special Agent Bomb Technician
GAO	Government Accountability Office
HCI	human-computer interaction
HDS	Hazardous Devices School
HI	horizontal integration
IED	improvised explosive device
IHEODTD	Indian Head Explosive Ordnance Disposal Technical Division
ISR	intelligence, surveillance, reconnaissance
JEOD	Joint Explosive Ordnance Disposal
JIEDDO	Joint Improvised Explosive Ordnance Disposal Defeat Organization
LNO	liaison officer
NAVSCOLEOD	Naval School Explosive Ordnance Disposal
NCKN	Naval Counter Improvised Explosive Device Knowledge Network
POV	point of view
RCRP	Readiness and Cost Reporting Program
SIPRNet	Secret Internet Protocol Router Network
TED	technology, entertainment, and design

TTP	tactic, technique, and procedure
USSS	United States Secret Service
VCP	virtual collaborative platform

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I. INTRODUCTION

A. PROBLEM STATEMENT

Information is currently being produced at a volume and velocity that surpasses the ability of individuals to make full use of it within a given time constraint—a condition often referred to as "information overload."[1] As a result, military leaders and their organizations are hindered in their ability to make sound decisions. Upon cursory inspection, it may seem doubtful, paradoxical even, that *more* information actually *impairs* decision makers in making well-informed choices.

As early as 1945, Vannevar Bush recognized an emerging problem with the means by which people process and access information. He observed that the current methods of navigating through the high seas of information for the coveted and relevant drops of recorded knowledge had not progressed since the "days of square-rigged ships."[2] In 1962, Doug Engelbart observed that while humankind's population and production were increasing, the "*complexity* of his problems [was growing] faster, and the *urgency* with which solutions" were needed had become critical.[3]

One explanation for the compounding pervasiveness of information is the notion that globalization and the Internet have helped to create the emergence of a "noosphere," a term coined by Pierre Teilhard de Chardin in 1925 to describe a global mind and "consciousness" where thoughts and information traverse the planet with the efficiency and character of a human nervous system.[4] While the emergence of a noosphere may have opened up a world of possibilities in the name of globalization, it has also created an

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1 George Pór, "Cultivating Collective Intelligence: a Core Leadership Competence in a Complex World," in *Collective Intelligence: Creating a Prosperous World at Peace*, ed. Mark Tovey (Oakton, VA: Earth Intelligence Network, 2008), 237; Muhammad Aljukhadar, Sylvain Senecal, and Charles-Etienne Daoust, "Using Recommendation Agents to Cope with Information Overload," *International Journal of Electronic Commerce* 17, no. 2 (2013): 43.

2 Doug Engelbart, "Augmenting Human Intellect: A Conceptual Framework," October 1962, http://www.dougengelbart.org/pubs/augment-3906.html

3 Ibid.

4 John Arquilla and David Ronfeldt, *The Emergence of Noopolitik: Toward an American Information Strategy* (Santa Monica, CA: RAND, 1999), 13.

information environment that is extremely connected and generative—not without some deleterious effects in the modern age. According to a recent study by eMarketer.com, 2013 is the first year that analysts estimate adults in the United States have spent more time participating in digital media than watching TV.[5] Clay Shirky hypothesizes that the reason for this shift is due to the fact that people fundamentally want to do three things with media: consume it, produce it, and share it. The difference is the current technology of the Internet is allowing people to do what they innately wanted to do, but could not do before: produce and share media.[6]

Due to the incredible affordability and ease with which information is created, the recently unrestricted latent desire to create and share it, and the highly connected infrastructure with which to move and duplicate it, information has accumulated faster than we can make sense of and order it. As a result, information required to create actionable knowledge is buried among other extraneous information with no readily effective means by which to separate the two.

B. ATTEMPTS TO SOLVE PROBLEM

This capstone project examines a collective intelligence solution for addressing the problems of information overload. I define collective intelligence as the heightened cognitive potential of networked humans made possible through an infrastructure such that the output is greater than the sum of its parts. My definition differs somewhat from others in the field of study because I contend that while the emergent behavior of humans within a complex adaptive system—think swarming—is necessary to achieve collective intelligence, by itself this is not a sufficient condition. In order for swarming behavior to occur successfully, it must be predicated upon an appropriate infrastructure to align the contributions of the individual into a framework useful to the group. Put another way,

5 Elise Hu, "Digital Seen Surpassing TV in Capturing Our Time," *All-Tech Considered: Technology News*, NPR, August 4, 2013, http://www.npr.org/blogs/alltechconsidered/2013/08/04/208353200/digital-seen-surpassing-tv-in-capturing-our-time

6 Clay Shirky, *Cognitive Surplus: Creativity and Generosity in a Connected Age* (New York: Penguin Press, 2010), 22–23.

before swarming can succeed, a hive must be built to sustain it. Before information can be processed, it must be restructured and organized in a useful way.

1. A Potential Solution: Collective Intelligence

Collective intelligence is not a new concept; rather it has quite a long pedigree in nature. For instance, collective intelligence has long been observed in the way that ants self-organize into groups to build bridges, form supply chains, and systematically search out new food sources in very intelligent ways.[7] Bees, baboons, and even bacteria have been documented to exhibit elements of collective intelligence whereby the group coheres to solve problems that could arguably not have been solved by individuals in the group alone.[8] Collective intelligence can also be seen in computers whereby being linked together they are able to combine processes to perform complex tasks that would not be achievable by any single computer. Another form of collective intelligence can be observed in groups of humans working together to solve complex cognitive tasks. The latter example is the niche of collective intelligence I am focusing on for this capstone project.

As an element of this human-centric theory of collective intelligence, emergence is the process by which "lower system elements" interact to create substance or potential at a "higher level of the system."[9] Such emergence is derived from macrocognition, which is a learning process whereby knowledge is enriched through compilation and composition emergence. Macrocognition affects the knowledge of the group by initially aggregating individuals with internalized, heterogeneous knowledge—the compilation emergence phase. Then, through a motivational impetus—shared culture, goals, or

7 Deborah Gordon, "Harmony without Hierarchy: Anarchy & Universal Love," *Earthling Opinion* (blog), June 21, 2012, http://earthlingopinion.wordpress.com/2012/06/18/harmony-without-hierarchy-anarchy-universal-love/

8 Howard Bloom, "Who's Smarter: Chimps, Baboons or Bacteria?: The Power of Group IQ," in *Collective Intelligence: Creating a Prosperous World at Peace*, ed. Mark Tovey (Oakton, VA: Earth Intelligence Network, 2008), 252.

9 Steve W. J. Kozlowski and Georgia T. Chao, "The Dynamics of Emergence: Cognition and Cohesion in Work Teams," *Managerial and Decision Economics* 33 (2012): 335.

affinity—members of the group collaborate, which leads in turn to shared, externalized knowledge—the composition emergence phase.[10]

Unfortunately, most macrocognitive processes in the military happen at the tactical unit level, not the organizational level. As a result, new knowledge that emerges and is learned is unevenly spread through the organization and languishes in hermetic silos, unless the knowledge is shared. Using a metaphor from physics, we can think of knowledge in terms of *inertia*: "knowledge at rest tends to stay at rest," something that Mark Nissen observes is a common symptom of today's organizations.[11] In order to catalyze the flow of knowledge, it must be spread throughout the organization. Collective intelligence as a problem-solving means is a better way to facilitate the spread of knowledge by inputting it into a focal point (i.e., a "hive") where the organization can interact with it on a massive scale. With all of the focus on "swarming," this capstone aims at shifting the attention from the desired output to the design considerations necessary to enable it. In this way, I am suggesting that before we can enable "swarming" to take place, we must first focus our efforts on "hiving," that is, carefully designing the effective infrastructure to enable swarming. Through the hive, actionable knowledge can be acquired by swarming individuals wherein information is accepted, rejected, or enriched into *better* actionable knowledge through iterative refinements. Subsequently, through self-organized and self-ordered mass interaction, an organization's actionable knowledge resource is increased, enabling better problem solving and decision making. Collective intelligence therefore can be seen as a macrocognitive process that serves to holistically deepen and improve the shared information and knowledge of groups through the interactive, collaborative experience.

For this capstone, information is defined as data that has been refined through a *contextual* integration. Data is expressed as a unit, say 5 as an example, and information ascribes a context to that unit—$5 or 5 days, etc. Knowledge emerges as a product of

10 Ibid., 343.

11 Mark E. Nissen, *Harnessing Knowledge Dynamics* (Hershey, PA: IRM Press, 2006), 32.

information processing by integrating *meaning* within a given environment.[12] Using the example above, knowledge could be expressed as $5 to purchase a bag of avocadoes at a local store.

The amalgamation of cognitive processes by which information is transformed into actionable knowledge is what I am defining as *intelligence*. However, an important distinction should be made—the amount of actionable knowledge is not proportional to that of information because while information can be integrated into knowledge, not all knowledge is *actionable*, that is, not all knowledge is relevant to a particular problem or decision. Conversely, not all of the information that is required to create actionable knowledge is readily available or easily retrieved—the deluge of information *conceals* as well as overloads our cognitive processes for acquiring actionable knowledge. Hence, more information is not always better for decision makers if they do not have the means to effectively process it.

2. Collaborative Web Portal to Generate Collective Intelligence

A collaborative web portal, for the purpose of this capstone, shall be defined as a robust collective intelligence website, made possible through the technology of the Internet to facilitate groups of users to collaborate on a massively large scale. Evidence of the tremendous collective power afforded by this framework can be seen in the democratic and demonstrative "crowd" movements such as the Arab Spring, Occupy Wall Street, and Anonymous—movements that could not have happened without the pre-requisite Internet-enabled sharing of richly spirited ideas and a self-ordering drive towards action.[13] Collaborative web portals can also take credit in large part for the successes of Internet moguls Google and Wikipedia, which aggregate the contributions of a collective to accomplish extraordinary achievements in scale and complexity.[14] It is precisely the power of these portals in allowing people to funnel and utilize knowledge,

12 Ibid., 509; Jennifer Rowly, "The Wisdom Hierarchy: Representations of the DIKW Hierarchy." *Journal of Information Science* 33, no. 2 (2007), 163.

13 "Understanding Incoma," *Incoma Project* (blog), accessed July 31, 2013, http://blog.incoma.org/understanding-incoma/

14 Ibid.

generate and propose new ideas, and foster disruptive *and simultaneously* constructive interaction that this project aims to distill to harness and align with the purposes of the EOD community.

I argue that a collaborative web portal is a means to address the information overload problem. The solution creates a platform to better enable leaders and organization to solve complex problems and make difficult and timely decisions. More to the point, this platform establishes a hive from which swarming can occur.

C. APPLICATION: EOD COMMUNITY CHALLENGES

In order to make a strong argument for the implementation of a collaborative web portal as a viable solution to be applied within the U.S. EOD community, we need to do the following: define and describe the community, state its purpose, determine how it creates value, identify its reporting ties, and explore its fundamental structural problems in which a web portal can provide a solution.

1. U.S. EOD Community Explored

The United States government employs EOD units both in the continental United States and abroad in all of the geographical combatant commands. As an exhaustive account, all four branches of the Armed Services maintain their own EOD force; so too does the Department of Justice direct the Alcohol, Tobacco, and Firearms Certified Explosive Specialist (ATF CES) and Federal Bureau of Investigations Special Agent Bomb Technician (FBI SABT) organizations; the Central Intelligence Agency, within the Security Protective Services (CIA SPS), has its own EOD force; and at the local law enforcement level, States maintain locally distributed bomb squads. All of these EOD organizations, along with the parent organizations that tie them together—all the way up to the Office of the President—is what I define as the U.S. EOD community. Within this community, I have accounted for 26 organizations and 83 links tying them together. Admittedly there are more organizations that could be included in this definition, but for clarity and brevity purposes I have opted to omit them.

Figure 1 provides a link analysis charting the organizations comprising the U.S. EOD community.[15] The link analysis offers four different types of organizations—administrative, operational, supported, and knowledge-centric. I define the administrative organizations as those that provide some type of administrative oversight for EOD organizations, but that do not themselves maintain EOD operators. The operational organizations, in contrast, are organizations that maintain EOD operators, or active bomb squads. Supported organizations are those that rely upon operational organizations to provide EOD operators in the support of their mission while knowledge-centric organizations are tasked by administrative organizations to procure, standardize, and disseminate formal EOD knowledge. Figure 2 provides a key for the four types of organizations.

15 The U.S. EOD community was drawn as a link analysis using open-source software metamaps. The map can be viewed by clicking here: http://metamaps.cc/maps/490. The mouse wheel zooms the map in and out as required.

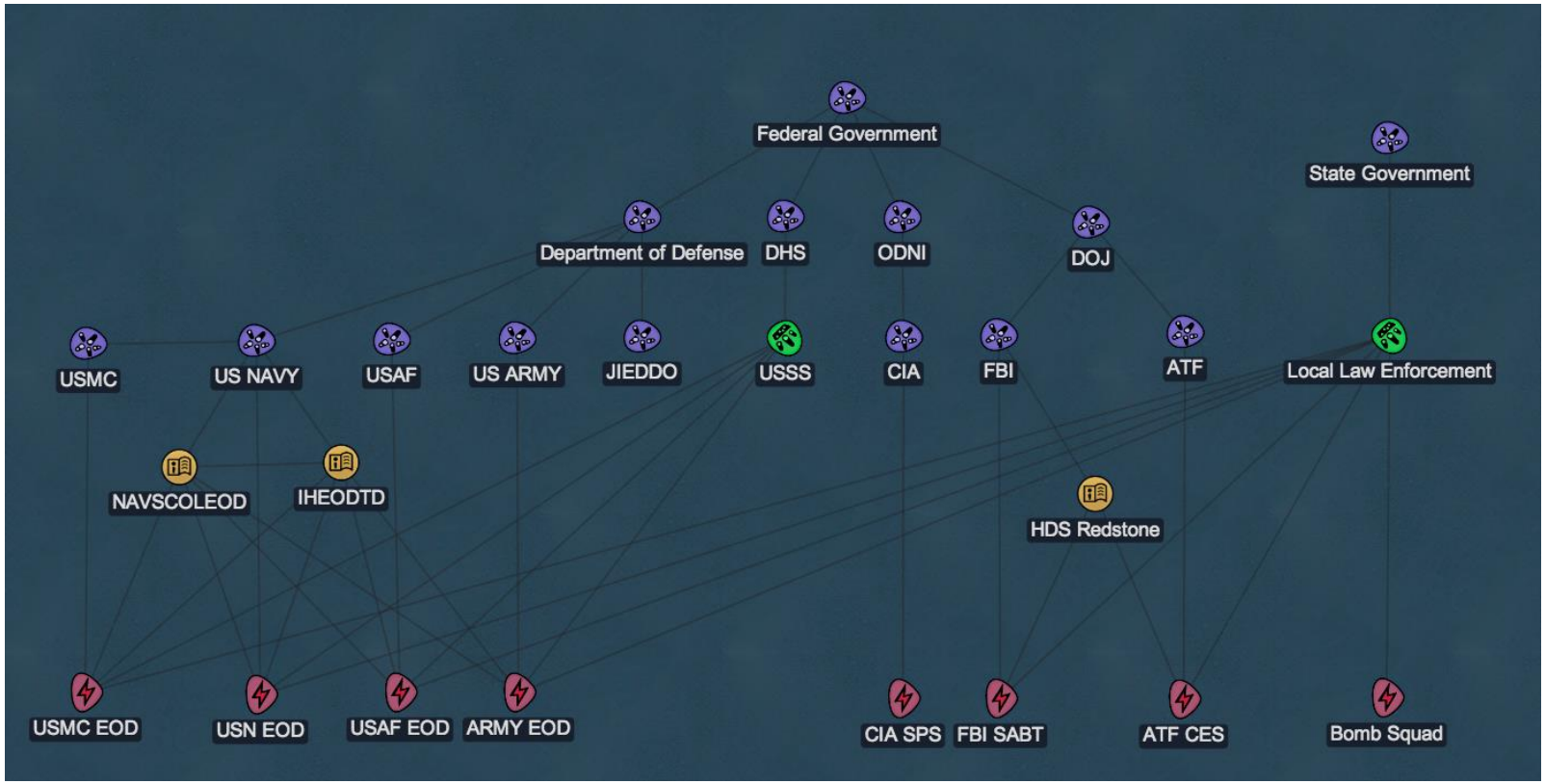

Figure 1. U.S. EOD community

Figure 2. Organizational codes

There are three types of relationships present in the EOD community—subordinate, learning, and service support. Subordinate relationships are the authority-based ties between administrative organizations (above) and subordinate organizations (below). A learning relationship denotes the exchange of formal knowledge from a knowledge-centric organization (above) and an operational organization (below) Finally, service-support relationships represent the unique exchange between supported organizations (above) and operational organizations (below). In this relationship, the operational organization provides members of its organization periodically to support the supported organization's mission.

a. U.S. EOD Community Purpose

While each of the EOD organizations affects the community in varying ways possessing differing capabilities, what they share is a common purpose: the responsibility and shared dedication for affording personnel and property, to the best of their ability, protection from explosives and other energetic material. When we distill this common mission to its epistemological roots, it becomes a system of problem solving within a

complex and volatile threat environment. Germane to EOD then is the cognitive processes by which ideas are synthesized into viable solutions, known colloquially as tactics, techniques, and procedures (TTPs).

However, herein lies the challenge: how can the deleterious effects of information overload be mitigated when the organizations that are creating the flood of data do not work together to collectively make sense of it all? As it is drawn, the U.S. EOD community is comprised of many organizations that perform or support EOD operations. However, they do not equally participate in the community and, to some extent, some organizations are hardly cognizant of what EOD operations even entail. To describe this community, I divide it into two different layers: *administrative* and *operational*. The administrative layer, Figure 3, highlights the superior-subordinate relationships directed downward from the Office of the President. The operational layer, Figure 4, illustrates how, based on their first-degree ties, operational organizations are formally connected.

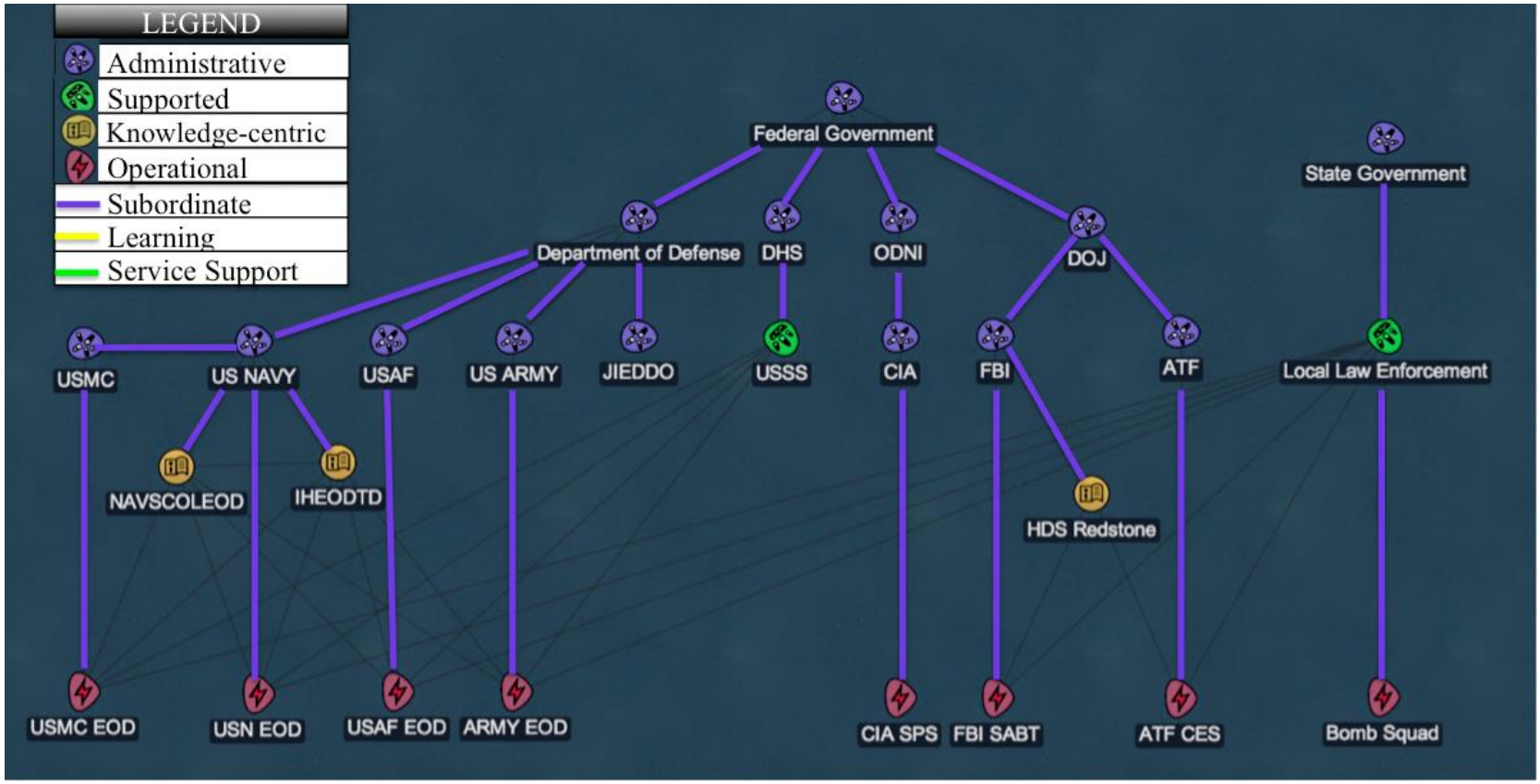

Figure 3. Administrative layer

b. U.S. EOD Community: Administrative Layer

These relationships chart organizations based on congressional authority or other legal documents. That said, all these organizations do not necessarily view themselves as part of this community with the expressed purpose of providing value for the furtherance of the EOD profession. No managers work to promote the large scale and sustainable cooperation necessary to provide optimal value for the community as a whole. Instead, each organization serves its own needs and purpose.[16] As a result, the organizations often duplicate efforts and stovepipe critical knowledge. Lessons learned are thus re-learned and repeated unnecessarily within the community. One reason for this is there is no codified process explaining for whom lessons are learned (intra-service, joint, or multi-agency) and no guidance or metric to ascertain whether a lesson is, in fact, learned. Additionally, the EOD community has no governing organization established as a "focal point for joint [or inter-agency] EOD doctrine."[17] Thus, the organizations within the EOD community struggle to acknowledge their common interests and purposes, as a recent report written for the congressional committees by the government accountability office (GAO) on DOD EOD resource planning and joint capability noted. One way of rewording the systemic problem within the EOD community is that it is not a cohesive and cooperative EOD *network*.

c. U.S. EOD Community: Operational Layer

Whereas the administrative layer of link analysis reveals the subordinate relationships that account for the U.S. EOD community, the operational layer of link analysis provides insight into which organizations are separated by a single degree from the operational organizations. Unlike the administrative layer, which was only connected

16 H. Brinton Milward and Keith G. Provan, *A Manager's Guide to Choosing and Using Collaborative Networks* (Hoboken, NJ: IBM Center for The Business of Government, 2006), 19.

17 Government Accountability Office, *Explosive Ordnance Disposal: DOD Needs Better Resource Planning and Joint Guidance to Manage the Capability* (Washington, DC: Government Accountability Office 2013), 17.

by superior-subordinate relationships, the operational layer is connected by superior-subordinate relationships, knowledge acquirement relationships, and service support relationships. Figure 4 illustrates this layer.

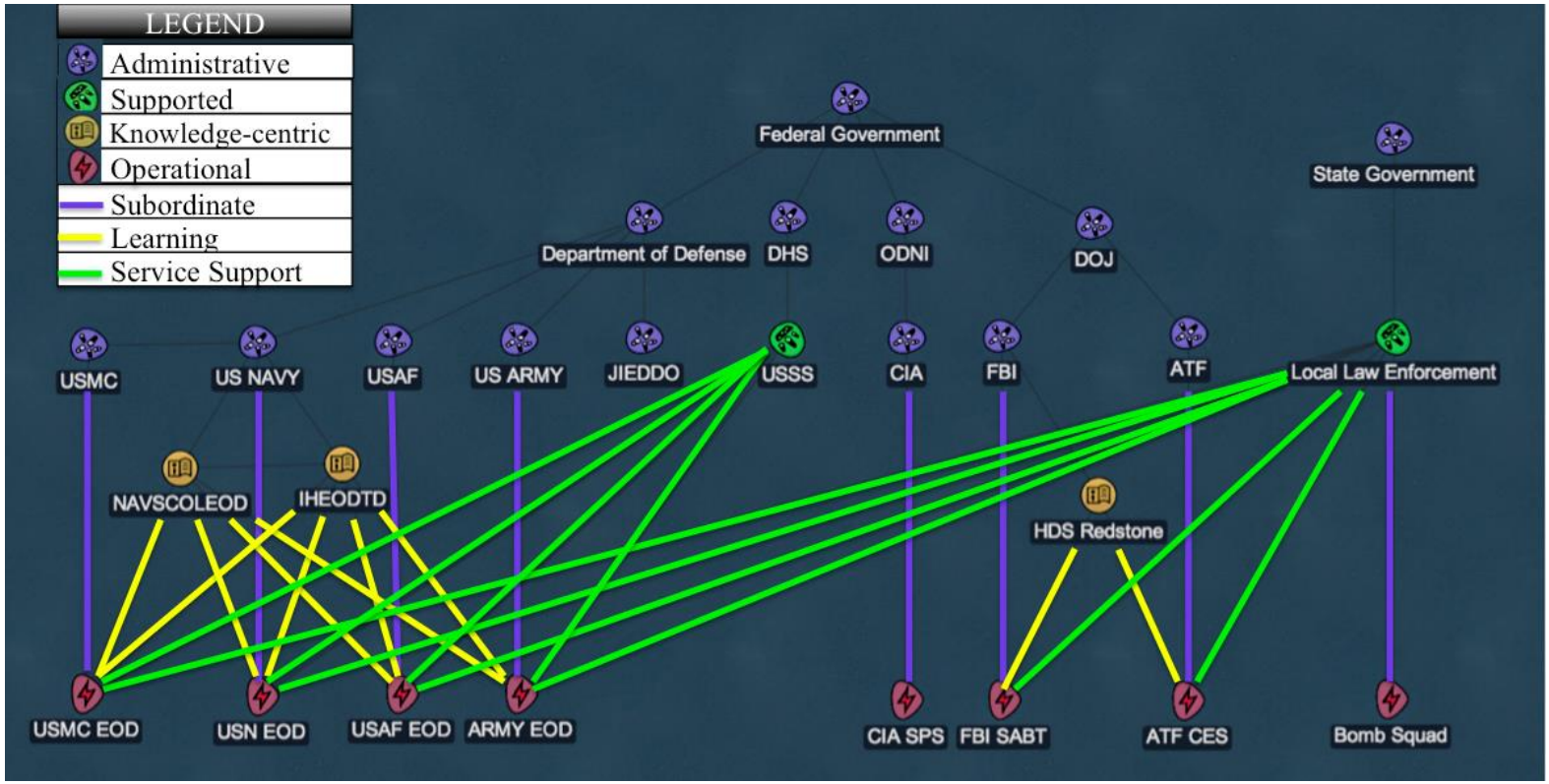

Figure 4. Operational layer

The main difference between the two layers of the U.S. EOD community is that within the operational layer, the nodes are connected to each other with fewer degrees of separation and the bridging nodes, that is, those that afford commonality to two or more nodes, are knowledge-based, not authority based. The nodes linking the operational organizations are the knowledge organizations (Naval School Explosive Ordnance Disposal, Indian Head Explosive Ordnance Disposal Technical Division and Hazardous Devices School) and supported mission organizations (U.S. Secret Service and local law enforcement). What this reveals in the U.S. EOD community is a high degree of interaction between the operators themselves, coming together at these hubs independent of their administrative superiors. Strikingly though, there are no formal links between the operational organizations to foster knowledge the sharing and merging of redundant efforts.

d. Network Analysis of EOD Community

The U.S. EOD community as a network *of* organizations (not to be confused with a *networked* organization) is extremely bureaucratic when examined through an authoritative layer link analysis. Each of the 26 organizations examined in the community has clearly defined roles and responsibilities within the scope of the federal or state government and has explicit authority from congress or other legal authority to do so. And yet, what is emerging from the operational layer link analysis is a degree of decentralized autonomy not unlike that of maneuver warfare in which isolated operators in the field, with a crystal clear understanding of commander's intent, are afforded great autonomy to make their own decisions based on a tacit and hard-to-replicate knowledge of explosive threats.[18]

Within the bureaucracy, there are clear authority ties, but the decisions with respect to EOD operations is so specialized and specific with regards to the entire federal government's roles and responsibilities that the decisions for EOD operations reside largely with the operational organizations themselves.

18 Clay Shirky, *Here Comes Everybody: The Power of Organizing Without Organizations* (New York: Penguin, 2008), 173; Chet Richards, *Certain to Win: The Strategy of John Boyd, Applied to Business* (Atlanta: Xlibris, 2004), 59.

e. Network Analysis: Locus Issues

One useful way to look at the network at the operational layer is through an examination of the *locus* of the network, that is, the "place, space, and pace" of EOD operations.[19]

(1) Place and Space Issues. The place of EOD operations is the location where the operations occur, and those locations are fraught with complexity and uncertainty. As a result of the complex place of EOD operations, the information space is flooded with data as individuals scramble to make sense of the operational environment and its unconventional threats, namely improvised explosive devices (IEDs) and other unconventional threats. Another problem is that the disparate cyber spaces created by EOD organizations to inform decision makers either do not offer timely information processing—what the data means within the context of EOD operations—or offer too much raw and unfiltered data, making it difficult for individuals within organizations to navigate to the relevant knowledge that is at the core of their profession. As such, rather than becoming an interactive space, the EOD webpages take the role of disorganized data repositories, essentially a top-down, one-way communicated website with human representation on the front end of the infrastructure only. Compounding the issue even further is the fact that the responsibility for maintaining the cyberspace is largely delegated to IT personnel within EOD organizations, who are often inadequately educated on EOD TTPs. As a result of their efforts, these individuals often tend to populate the webpages with superfluous information. Last, the small groups of personnel charged with populating the webpages are often overwhelmed with the velocity, variety, and volume of data that they are required to process.

(2) Pace Issues. The pace of the U.S. EOD community is extremely fast, fueled largely by nefarious dark networks' use of the Internet to quickly and covertly disseminate enemy TTPs. As the primary purpose of the EOD community is to keep abreast of explosive threats, the pace must be as fast and scalable as the explosive threats themselves. Therefore, since the administrative bureaucracy cannot maintain the pace

19 Patti Anklam, *Net Work: A Practical Guide to Creating and Sustaining Networks at Work and in the World* (Oxford: Elsevier, 2007), 81.

required by the operational adhocracy, there is an imbalance between the place and space within the U.S. EOD network because the pace is unsustainable.

The main issue is that the authoritative structure is almost polarly opposite to the operational structure. This results in design tensions because how the EOD community is formally drawn up in the authoritative layer is incongruent with the operational layer. This is not to suggest that the bureaucracy is incompatible with the operational network or vice versa, but that certain corrective measures must be implemented to realign the two layers of the network with the overall purpose of the network whole. With proper measures taken, a balance can be struck between the bureaucratic authority sub network and the ad hoc operational one.

f. Network Analysis: Environment Issues

Regarding the environment, there is an issue with regards to the environment of the administrative layer and the threat environment in which the operators in the operational layer are operating. Specifically speaking, the bureaucracy is too rigid and ill-disposed as a dialectic machine to implement an effective strategy for organizations whose operations, dictated by a volatile and uncertain threat environment, must be flexible and adaptive to succeed. As explosive threats are by their nature dynamic, continuing to expand and develop, so must the problem solving process be fluid and adaptive to match and overcome it. Adding further validation that explosive threats are dynamic and continuing to evolve is the fact that terrorist organizations like al-Qaeda are collaborating in decentralized cells, using the Internet as a massive launch pad to disseminate IED blueprints that individuals with only rudimentary explosive and electrical engineering skills can use to produce deadly devices with relative ease. The recent IED attack in Boston by the Chechen brothers Dzhokhar and Tamerlan Tsarnaev is a particularly salient example of the ability of "lone wolf" terrorists to self-organize and self-teach the methods to lethally employ explosive threats.[20]

20 James Bamford, "Inspire Magazine: The Most Dangerous Download on Earth," *Newsmakers*, December 2013, http://www.gq.com/news-politics/newsmakers/201312/inspire-magazine-al-qaeda-boston-bombing, 1.

2. U.S. EOD Community: Point of Intervention

In order to achieve this harmony of effort between the operational and administrative layers, this project argues for the creation of a web portal for the purposes of informal networking, collaboration, and the sharing of knowledge. It is not the aim of this capstone to create a new infrastructure, but rather to demonstrate a concept that can then be adopted and implemented into existing EOD web infrastructure. Due to the sensitive nature of EOD TTPs, the likely location for this framework would be on the SIPRNet as a subset of the joint EOD (JEOD) portal managed by the Indian Head EOD Technical Division (IHEODTD). Already residing on this portal is the automated EOD publication system (AEODPS), which acts as the primary source of formal EOD doctrine. Placing this capstone's concepts on the same portal makes sense because the formal and informal knowledge sharing can augment each other—the one can reference the other and vice versa. Additionally, co-locating informal and formal knowledge on the same portal acts as a force multiplier by allowing users to acquire greater value from one source.

Knowledge produced in the field must be allowed to flow directly back into the field, providing operators the most current knowledge. As a knowledge portal, the website would enable users to produce content, respond to content, and consume content. Additionally, users can actively contribute by self-organizing around topics they are interested in, experienced in, and passionate about, as well as ordering the inputs of others into a viable and interactive forum. This construct empowers users to transcend the traditional reliance upon bureaucratic institutions as sole providers of knowledge and allows them to start providing value for themselves independent of any administration. This does not remove the authority from the bureaucracy, but rather it augments the bureaucracy and relieves some of the burden of having to provide all EOD knowledge. The administrative and operational networks therefore augment themselves by shifting from one to the other the tasks they are better equipped to perform. As a result, the U.S. EOD community as a whole is provided an improved capability to flex and adapt in order to best respond to explosive threats in the field. This give and take is a necessity if the U.S. EOD community is to cope with information overload.

The counter-argument that may be presented suggests that decentralizing the knowledge procurement process is dangerous. This argument follows that by allowing people to generate knowledge by and for themselves, thus circumventing the sanctioned institutional filters, disinformation and unsafe practices would likely emerge, leading to injuries, deaths, and property damage. While this alarmist point of view may seem well grounded, it is in fact demonstrative of a causal loop diagram that reveals exactly the opposite. First, EOD operators in the field are already given great autonomy due to implicit trust in their sound judgment to make good decisions. That trust in the field naturally extends to individuals being able to decide for themselves what knowledge proffered by others is good, and what is not, whether it be face-to-face or on a classified website. Therefore, more autonomy leads to better ability to exercise judgment and make timely decisions. More relevant knowledge, paired with an already trusted and proved judgment, leads to better timely decisions, not worse, which reinforces the trust in superiors to afford more autonomy to subordinates.

Conversely, those making tough calls in the field are enabled to do so by their ability to acquire current and relevant knowledge. What the bureaucratic structure lacks inherently is the ability to quickly produce artifacts that operators in the field can use. Therefore, despite the best intentions of the knowledge institutions to provide up-to-date information that is vital to operators in the field, they will never be able to provide it as fast as those who are already in the field and whose combined numbers are far greater than the relatively small group of individuals burdened with collecting, processing, vetting, and disseminating knowledge. Therefore, while there is some risk that knowledge entered into the website that this capstone advocates may be unsubstantiated or harmful, more harmful is the reality that EOD operators in the field are potentially without the very knowledge that could save their lives and the lives of others, information that is possibly already residing in the heads of other EOD operators without the means to widely share it.

The kind of informal networking that this capstone espouses is already taking place, and has been for years. After every exercise or mission, the individuals involved conduct conversations rich with tacit knowledge, and continue to call on each other for

advice, independent of any authority. There is no authority present during those discussions to weigh in and control that conversation's content. The individuals participating in the discussion process the knowledge that is shared and enrich it, culminating in a proposed solution. The problem, however, is that up until now, with the advent of social media and websites that enable users to interact to create value for themselves that knowledge could not easily be recorded in an organized and ordered way. Now it can be presented to everyone with access to it, with greater ability to learn from it and a wider diversity to enrich it. It is precisely the size of the group, the diversity of the group, and the number of interactions between members of the group, communicating in a many-to-many dynamic afforded by collaborative web portals that allows amateur users to produce knowledge artifacts that are often superior to that produced by a much smaller group of professionals in the same profession. Evidence of this is seen in news articles on blogging sites, Wikipedia, open source software projects, and many more generative professions that rely on accurate knowledge with minimal errors.

Another point is that decentralizing certain aspects of governance does not usurp authority from the bureaucracy—the two network design elements can exist in concert quite well. The decentralized knowledge network can augment the efforts of the knowledge institutions, and the official knowledge gate keepers can participate, along with other revered members of the EOD profession, to lend credibility to, or moderate, the contributions of others.

As a community of practice, the website would pool the diverse contributions from passionate volunteers to enrich the knowledge of the entire U.S. EOD network, not just the individual organizations. The rate of success for acquiring new knowledge and promoting innovative solutions is predicated on the size of the participation pool and the diversity of the participants themselves. Users are incentivized to participate in at least two very powerful ways. First, users receive great pride when their peers recognize their ideas publicly as being meritorious. This in turn promotes them to volunteer more time contributing content to the website. As well, users are also incentivized to help others on the website because, within the EOD profession, there is a deeply implicit notion of reciprocity. The users help others within their profession because they believe that in

doing so, others will help them out when the time comes. In this way, the knowledge network becomes a living organism, since real people are present on both the front and the back ends of the infrastructure—they are there to ask questions as well as answer them, or they can learn from the conversations of others. As such, the value added would be a collective intelligence open for all of the EOD organizations to tap into with a return far greater than the sum of its parts.

The knowledge institutions can likewise benefit by being introduced to knowledge they may not have received until a later time. In this way, they can benefit by incorporating the contributions of other EOD users in their job of formally disseminating knowledge—the informal knowledge can enrich and produce better formal knowledge after having been vetted by more users. While it may seem dubious to make the claim that informal contributions can often generate knowledge with fewer mistakes than formal knowledge institutions, the cases of Wikipedia and Linux show that open-source systems often achieve an output with fewer errors. The reason for this can be explained through Linus's law,[21] which states, "With enough eyes, all bugs are shallow."[22]

D. DESIGN THINKING

This capstone examines the EOD community's challenges with information overload through a design thinking lens. Design thinking is well suited for highly nuanced and complex environments precisely because it intentionally creates conditions to holistically examine problems. It does this by taking a multidisciplinary approach to problem solving to illuminate and embrace blind spots left unchecked in traditional methods—it is "transcendent of particular contexts, specific disciplines, or single concepts."[23] Rather than try to define a problem at the outset, design thinking challenges individuals to frame and reframe problems. Often we are prevented from discovering

21 Named after Linus Torvalds, the creator of Linux.

22 Shane Greenstein and Feng Zhu, "Collective Intelligence and Neutral Point of View: The Case of Wikipedia," National Bureau of Economic Research, June 2012, http://www.nber.org/papers/w18167, 7.

23 Harold G. Nelson and Erik Stolterman, *The Design Way: Intentional Change in an Unpredictable World* (Englewood Cliffs, NJ: Educational Technology, 2003), 2–3.

good solutions not through fault of our solution development, but because we fail to understand, wrongly define, or attempt to "tame" or simplify problems in the first place.[24]

Design thinking is a creative process biased toward action that wills into being what is absent but necessary in society.[25] Instead of attempting to tame problems to fit a solution set we are already committed to, design thinking aims to free us from our conceptual prisons. If a given problem's solution is not possible with the current infrastructure, the challenge is to "figure out what infrastructure would make it possible, and cause it to come into existence."[26] Thus, design as a process is not an execution checklist that concludes with a finished or complete product. The late Air Force strategist Col. John Boyd captures the point well:

> Back and forth, over and over again, we use observations to sharpen a concept and a concept to sharpen observations. Under these circumstances, a concept must be incomplete since we depend upon an ever-changing array of observations to shape or formulate it. Likewise, our observations of reality must be incomplete since we depend upon a changing concept to shape or formulate the nature of new inquiries and observation.[27]

Design thinking, in summary, is an iterative and ongoing process that comfortably embraces the incomplete.

Another key aspect in design thinking is gaining empathy for users. Solutions to problems in a connected society such as ours are not innocuous devices—they are strongly connected to people and deeply affect their lives. The way in which a solution is designed, and how it is implemented to fix a given problem, is immediately and intimately felt by a great many people. These second-order effects can trigger grave consequences. Similarly, defining problems in today's complex operational environments

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24 Ibid., 13.

25 Ibid.

26 Mark Tovey, "Mass Collaboration, Open Source, and Social Entrepreneurship," in *Collective Intelligence: Creating a Prosperous World at Peace*, ed. Mark Tovey (Oakton, VA: Earth Intelligence Network, 2008), 464.

27 John Boyd, "Destruction and Creation," in *Boyd: The Fighter Pilot who Changed the Art of War*, ed. by Robert Coram (New York: Back Bay Books, 2002), 456.

cannot be achieved from a single vantage point. Rather, a range of stakeholders' views must be taken into account in order to understand problems more fully, and to flesh out the repercussions of their solutions more presciently. In designing for a particular problem, identifying the potential users of what is being designed and maintaining a close relationship with them greatly improves the effectiveness of the solution.[28] Without maintaining a running dialogue with users of a potential solution, designers run the risk of wrongly defining what the problems are and ultimately worsening the issue. By accounting for a diverse set of stakeholder perspectives, designers are better able to observe problems as systems of interrelated parts. Thus, design thinking is a very interpersonal process that purposively immerses designers in a creative marriage between themselves and their users.

E. STRUCTURE OF CAPSTONE

This chapter has laid out the groundwork regarding the problem of information overload and the intent of this project to apply a collaborative web portal to mitigate it. This chapter also presented the case for why this solution is appropriate within the context of the EOD community. Chapter II provides a literature review by first exploring alternative coping methods for the information overload problem and then gives an in-depth exploration of collaborative web portals and the associated technology they embrace. Chapter III explains the design thinking methodology this project uses and Chapter IV offers and analyzes the results of that methodology in the form of a comprehensive prototype review. Chapter V concludes with future recommendations and makes suggestions for furthering the project.

28 "Bootcamp Bootleg," Stanford, February 12, 2014, http://dschool.stanford.edu/wp-content/uploads/2011/03/BootcampBootleg2010v2 SLIM.pdf, 1.

II. LITERATURE REVIEW

In this chapter, I examine some historical and contemporary options to deal with information overload. Next, I offer an overview of an innovative and holistic web approach, called Web 2.0, which promises to be a *better* means for coping with information overload, especially for military leaders in distributed environments. The remainder of the chapter offers an in-depth look at Web 2.0 to include its advantages, limitations, and application challenges.

A. COPING WITH INFORMATION OVERLOAD

1. Organizational Restructuring and Redesign

Organizational structure can be redesigned[29] in a number of ways to realign an organization's efforts and purpose. However, discussing information overload within an organizational context requires an analogous framework. Jay Galbraith's theory of information processing is central to coping with information overload and is predicated on the following: "the greater the task uncertainty, the greater the amount of information that must be processed among decision makers during task execution in order to achieve a given level of performance."[30] To cope with the strain of information, an organization can respond by reducing its need for information processing or increasing its capacity to process information.[31] Galbraith presents four design strategies to accomplish the above goals. However, it is important to note that the four strategies are not exclusive and can be combined in various ways.

a. Increase Slack Resources

To reduce its requirement for information, the organization can respond by increasing its slack resources. According to Galbraith, when an organization does not

29 In this sense, design can be thought of as a means by which the structure of the organization can be manipulated, but later in the capstone this term will also entail a process.

30 Jay Galbraith, *Designing Complex Organizations* (Menlo Park, CA: Addison-Wesley Publishing CO, 1973), 4.

31 Ibid., 15.

have the capacity to process a given volume of information within a specified time, it can cope by "increasing the resources available rather than by utilizing existing resources more efficiently."[32] Galbraith emphasizes that in this design strategy the organization does not choose to ignore the efficiency of resources, but does not possess the capability to coordinate their use to be shared among many parts of the organization. Thus, this design strategy purposely induces inefficiency into the system, but maintains overall output as an aggregate of more resources. As the degree of uncertainty increases, the organization must respond by increasing its slack and reducing performance. However, performance in this sense pertains to an organization's utilization of resources, not its overall output. By increasing the resources available to it, the organization can accomplish all of the jobs it is assigned, although the means by which it accomplishes it will be inefficient. By increasing what the organization has available to it to perform tasks, the information processing required to coordinate the sharing of resources is reduced. This increase can be in the form of time, manpower, or equipment. The cost incurred is that of sustaining an excess of resources in the form of longer task completion time, increased manpower, and redundant systems.[33]

b. Creation of Self-Contained Tasks

The second way to reduce an organization's dependence on information processing is by creating self-contained tasks. Accordingly, groups are identified to work on unique tasks such that their diversity of output, that is, what that group can be tasked to do and what it can decide on, is more narrowly focused.[34] Whereas increasing slack resources provides more resources to be shared among one group, this solution obviates the need for sharing altogether by creating groups with independent resource requirements. Since each group has a specific field of responsibility, decision making can be delegated "closer to the source of information," thereby reducing the information load on the hierarchy.[35] The downside of this design strategy is that it creates a decrease in

32 Ibid., 24.

33 Ibid., 25.

34 Ibid., 27.

35 Ibid.

demand for all of the groups. Independently created groups created to perform only one task default back to an inactive status when that task is completed rather than assisting other groups with their tasks.[36]

c. Investment in Vertical Information Systems

The third form of organizational redesign is the investment in vertical information systems. Where the two previous design strategies reduce the information load on the organization, this strategy increases its capacity to process information. This strategy augments existing communication channels and creates new ones through the utilization of computers and information technology.[37] Through the use of global databases, members of the organization can access and manipulate data in real-time, thereby improving the organization's awareness and obviating the need to periodically consolidate local operations. Additionally, implementing formal reporting processes enables individuals in the organization to convey great amounts of information with fewer symbols, saving the organization substantial time and resources.[38] The disadvantage of this design strategy is that there is substantial cost associated with maintaining the required staff to design and maintain the reporting systems. Additionally, not all information is congruent with formal systems; non-routine and qualitative communication may be incompatible with formal systems but no less important for the health of the organization. Finally, unless an effective means exists to process the information, more of it is not necessarily a good thing. [39]

d. Creation of Lateral Relations

Galbraith's final design strategy is the creation of lateral relations. In this approach, the decision making process is again brought closer to the source of information, but instead of assigning it to self-contained task groups, this strategy encourages nodes in the organization to informally cooperate to solve problems and make

36 Ibid., 28.

37 Ibid., 32.

38 Ibid., 33.

39 Ibid., 34.

difficult decisions. Additionally, this strategy encourages the combining and sharing of assets between nodes to identify and combine redundancies.[40] As an example of this option, the military has espoused a "whole-of-government" approach in the form of "horizontal integration" (HI) to improve the ability of information consumers to disseminate, analyze, and produce information for the warfighter.[41] The advantage of HI as a business strategy can be illustrated through a ten-year study of Pakistani textile manufacturers where 15 vertically integrated ones were compared to 15 horizontally integrated ones. The result was an output of more than two to one in favor of the HI variant.[42]

The problem with the military HI solution as it is currently proposed is its reductive quality—the strategy for overcoming the cognitive limitations of analysts to synthesize and digest information to a degree of usefulness is simplified to the establishment of "cross-domain architectures of the Distributed Common Ground System (DCGS)/DCGS Integrated Backbone" and the necessity for open sharing of data.[43] As such, HI makes possible the sharing of information, but says nothing about how to make that information usable. In a sense, this taming of the information overload problem is treating data as a desired output in the same way as the Pakistani textile manufacturers—more production is better. However, as previously stated in the section on vertical integration, more is not better if it cannot be effectively processed. As Mark Nissen writes, "Yet the wealth of knowledge resides within the analyst performing the queries and mining the data, not the database. The actions are enabled by knowledge learned through analysis, not data stored on disk."[44] Thus, by itself, the HI solution does not effectively manage information overload.

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40 Ibid., 46.

41 Chairman of the Joint Chiefs of Staff, *Horizontal Integration of Warfighter Intelligence* (Washington, DC: Government Printing Office, 2008), http://www.dtic.mil/cjcs_directives/cdata/unlimit/3340_02.pdf, 1.

42 Muhammad Imtiaz Subhani, Syed Akif Hasan, Muhammad Nayaz, Amber Osman, "Bye to Vertical Integration and Welcome to the Horizontal Integration in the Textile Business," *International Research Journal of Finance and Economics* 98 (2012): 144.

43 Ibid., 7.

44 Mark E. Nissen, *Harnessing Knowledge Dynamics* (Hershey, PA: IRM Press, 2006), 23.

Galbraith specifies that while this strategy holds great promises for organizations, several factors must be considered in order to facilitate the necessary cooperation among groups of people. Active managers and leaders need to be brought in to smooth the complex dynamics of group interaction and the lateral process itself must be incorporated into the vertical one to avoid cross-purposes.[45]

2. Face-to-Face Group Problem Solving and Decision Making

Face-to-face groups, who come together to communicate, share information for problem solving and decision making. This information management approach has been around since the dawn of time going by many different names: tribal meetings, town square debates, conferences, working groups, circles, and many more. What connects these various approaches is their co-location within a physical space. Where this departs from Galbraith's theory is that members are not restricted by organizational boundaries. Inter-organizational and –agency face-to-face deliberations are occurring to solve difficult problems independent of hierarchy. Due to the highly personal nature associated with this form of information processing, tremendous results are attained through a dialogue in which all members of the group have an equal chance to provide their opinion. By listening to the conversation, members become better educated on the subject and can react to the comments of others directly in a collaborative and highly interactive way.[46] For groups that know each other well, face-to-face group information processing is ideal for extremely time-sensitive decisions in which shared knowledge among the group can reduce the necessity to communicate as often, making the group more efficient

45 Galbraith, *Designing Complex Organizations*, 54, 58.

46 Peter Miller, *The Smart Swarm: How Understanding Flocks, Schools, and Colonies Can Make Us Better at Communicating, Decision Making, and Getting Things Done* (New York: Avery, 2010), 96.

as a result.[47] Face-to-face group information processing is also credited as being the "cheapest and most effective way to maximize your throughput."[48]

Peter Miller explains that the effectiveness of face-to-face deliberations is optimized when the following principles are met: "seek a diversity of knowledge. Encourage a friendly competition of ideas. Use an effective mechanism to narrow your choices."[49] The downside to this solution for addressing the problem of information overload, then, is that the group must be successfully managed by a skilled moderator or facilitator well versed in group dynamics. Additionally, depending on the scope of the issue being deliberated and the amount of information that must be processed, there are quickly surpassed limits to what these types of groups can accomplish in the time allotted them. Face-to-face group information processing is also limited by a need to be co-located, requires an exhaustive availability of time and simultaneous participation, incurs transportation costs for those not co-located, and is un-scalable.[50]

3. Computer Algorithm Approach

Doug Englebart conceptualized "augmenting human intellect" by proposing the development of new ways for aligning humans and the problems they were trying to solve—with limited cognitive bandwidth—through advents in "technology, procedures, and systems."[51] This line of thinking inspired many computer programmers to look for ways that computers could be used to not only aid in the retrieval and processing of

47 J. Alberto Espinosa, F. Javier Lerch, and Robert E. Kraut, "Explicit Versus Implicit Coordination Mechanisms and Task Dependencies: One Size Does Not Fit All," in *Team Cognition: Understanding the Factors that Drive Process and Performance*, eds. Eduardo Salas and Stephen M. Fiore (Washington, DC: American Psychological Association, 2004), 108.

48 Alex Pukinskis, "Co-located Teams," in *Agile Business: A Leader's Guide to Harnessing Complexity*, eds. Bob Gower and Rally Software (Boulder, CO: Rally Software Development Corp., 2013), 111.

49 Miller, *The Smart Swarm*, 93.

50 Peter A. Gloor, *Swarm Creativity: Competitive Advantage through Collaborative Innovation Networks* (Oxford: Oxford University Press, 2006), 87; Jitesh H. Panchal and Mervyn Fathianathan, "Product Realization in the Age of Mass Collaboration," ASME Design Automation Conference, August 2008; "Understanding Incoma," *Incoma Project* (blog), accessed July 31, 2013, http://blog.incoma.org/understanding-incoma/

51 Doug Engelbart, "Augmenting Human Intellect: A Conceptual Framework," October 1962, http://www.dougengelbart.org/pubs/augment-3906.html

information, but to do so automatically. To accomplish this, computer algorithms were developed to handle data inputs and automatically categorize them, manipulate them, and provide other means to make the data more useful. In this capacity, computers are said to provide "intelligence amplification," whereby the mental capacity of humans using computers is improved by aiding in memory retrieval and high order computations.[52]

Undoubtedly, computer algorithms have progressed a tremendous amount since Englebart's time. Perhaps the best example at present is IBM's super computer, Watson, which first earned notoriety when it competed as a contestant and took first place in the game show Jeopardy! in 2011.[53] Today, Watson is being used at select hospitals and medical centers to aid doctors and nurses. According to a recent *Forbes* article, "[d]octors and nurses are drowning in information with new research, genetic data, treatments and procedures popping up daily. They often don't know what to do, and are guessing as well as they can."[54] Using advanced natural language processing algorithms, Watson cross references inputs from doctors and nurses with its "605,000 pieces of medical evidence, 2 million pages of text, [and] 25,000 training cases" to provide likely diagnoses and courses of action with a confidence level in the form of a percentage for each one. As an information processor, Watson does not direct doctors to take courses of action, but augments decision making by providing options the doctor might take along with the supporting evidence it used to make its determination. According to the article, health care professionals provide accurate treatment assessments only 50 percent of the time; studies have shown Watson is accurate at providing correct diagnoses and treatments 90 percent of the time.[55]

The problem with computers as information processors is they are also information multipliers. While their use affords tools to process information and search

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52 John B. Smith, *Collective Intelligence in Computer-Based Collaboration* (Hillsdale, NJ: Lawrence Erlbaum Associates, 1994), 4.

53 Bruce Upbin, "IBM's Watson Gets Its First Piece of Business in Healthcare," February 08, 2013, http://www.forbes.com/sites/bruceupbin/2013/02/08/ibms-watson-gets-its-first-piece-of-business-in-healthcare/

54 Ibid.

55 Ibid.

for knowledge, computers also enable users to cheaply and easily produce and share data and information. Therefore, while advancements in computer technology have demonstrated great potential for information processing, computer use is still the main culprit for bringing big data to fruition. Additionally, computers are advantaged in repetitive and logical tasks, but they are inept at performing right brain skills requiring creativity and imagination.[56] In this way, we may consider computers to be a necessary condition, but not a sufficient one, for managing information in the pursuit of solving complex and wicked problems.[57]

B. NEW APPROACH: WEB PORTALS

The web portal solution begins with technology referred to as Web 2.0, which is integral to any collaborative Internet environment. The first section illustrates how Web 2.0 can be a means to augment collective intelligence and knowledge management. The next section explores the benefits and challenges of implementing Web 2.0 technologies to create value for participants. Lastly, a summary of evidence suggests that collaborative web portals are best approached using design thinking with the end user in mind. To cope with information overload correctly, leaders cannot simply build a thing and consider the issue remedied. What they build must be built right, and that begins with identifying the end-users and how they will interact with the system. The framework presented suggests various ways to manipulate the web portal structure to better align the desired output and end-users.

1. Web 2.0

Collaborative web portals are built upon the principles of an Internet evolution known as Web 2.0. Up until roughly 2004, during the Web 1.0 era, users could only consume content on websites—the information flowed in only one direction (hence 1.0) from the Webmaster to the user. Web 2.0 is the result of a tipping point as advances in "technology, demographics, and the world economy" alter the methods of production

56 Scott Klososky, *The Velocity Manifesto: Harnessing Technology, Vision, and Culture to Future-Proof your Organization* (Austin: Greenleaf Book Group Press, 2011), 264.

57 Smith, *Collective Intelligence in Computer-Based Collaboration*, 4.

from a strictly top-down leadership model with centralized control to alternatives exhibiting informal networks, self-organization and mass collaboration.[58] Internet guru Tim O'Reilly refers to Web 2.0 as a platform that generates value based on user-generated content rather than on traditional resources developed by a company or institution.[59] In simpler terms, Internet users become "prosumers" of Internet content, that is, they suddenly can be producers and editors of content as opposed to only consumers of it. Their role in the media landscape is no longer strictly passive. As Web 2.0 expert Clay Shirky explains, we are moving away from a television-dominated media where only consumption is possible. As a naturally occurring byproduct of human psychology, people have always held a desire to produce, share, *and* consume thoughts and ideas, but only recently has Internet technology afforded people the ability to do so as cheaply, ubiquitously, and with such a powerful effect as they do today.[60] Web 2.0, therefore, does not alter human behavior, but rather enables latent social activities that could not be performed before because the technology necessary to perform them had not yet been created or was too expensive for the masses to embrace. As a result of this technological shift, today anyone with an Internet connection and a computer or mobile device can instantly become an author, critic, or editor of and potential collaborator on any topic they desire. To cement the importance of Web 2.0 as a viable force in today's social sphere, 2013 has been identified by experts as the first year in which people will spend equal time using digital media as they do watching television.[61]

At this point, one might naturally question how Web 2.0 websites work and why they are a *better* option than organizational redesign, face-to-face group information processing, or computer algorithms. The simple answer is that collaborative web portals holistically aggregate the successful traits of all of those solutions while avoiding their pitfalls. Web 2.0 is a distributive and participative solution that is not restricted by organizational boundaries and limitations. Collaborative web portals fuse the strengths of

58 Don Tapscott and Anthony D. Williams, *Wikinomics: How Mass Collaboration Changes Everything* (New York: Penguin, 2010), 1, 10.

59 Miller, *The Smart Swarm*, 136.

60 Shirky, *Cognitive Surplus*, 22; Klososky, *The Velocity Manifesto*, 221.

61 Hu, "Digital Seen Surpassing TV In Capturing Our Time."

group information-processing and computer algorithms by affording participants a membership in a community to solve problems. Small groups succeed by highlighting the personal attributes that are necessary to solve complex problems, that is, stakeholder perspective taking, empathy, and creativity. Successful group information processing also promotes a dialogue that can enrich the knowledge of all participants. Collaborative web portals augment those aspects of face-to-face deliberation by providing the means to communicate in larger groups than would be possible in a physical space.

A computer algorithmic approach is suited for complex objective functions like mathematical computations and sizeable informational database retrieval, as Watson clearly demonstrates. Successful collaborative web portals recognize the importance of computer algorithms and provide them as a means to augment users' participation. A collaborative web portal therefore combines the human quality, which it provides through a virtual meeting space, and the computational aspects of complex retrieval, advanced informational filtering, and ordered display, by connecting humans the world over and affording them the use of highly sophisticated computational tools to augment their cognition.[62]

2. Features of Web 2.0 Platforms

Web 2.0 websites use different governance for different purposes. Governance, in this instance, refers to the system of rules, rewards, and norms that order the output of the website to create value for particular users. What all Web 2.0 websites share is a commons-based production system that is based on open participation, diversity, reciprocity, and a system of rewards—be it designs for T-shirts (https://www.threadless.com), automobiles (https://localmotors.com), and computers (http://www.ideastorm.com) or the generation of encyclopedia articles (http://Wikipedia.org), software code (http://www.linux.com), or solutions to here-to-fore

62 By cognition, I refer to the psychological form of the word, not the philosophical one, to include the mental processes George Pór defines as "complex differentiation"—recognition, retrieval, memory—and "complex integration"—learning, reasoning, and understanding; George Pór, "Cultivating Collective Intelligence: a Core Leadership Competence in a Complex World," in *Collective Intelligence: Creating a Prosperous World at Peace*, ed. Mark Tovey (Oakton, VA: Earth Intelligence Network, 2008), 236.

unsolvable military problems (http://armycocreate.com).[63] Figure 5 contrasts Web 1.0 with Web 2.0 to highlight the advantages brought about by a tipping point in Internet technology.

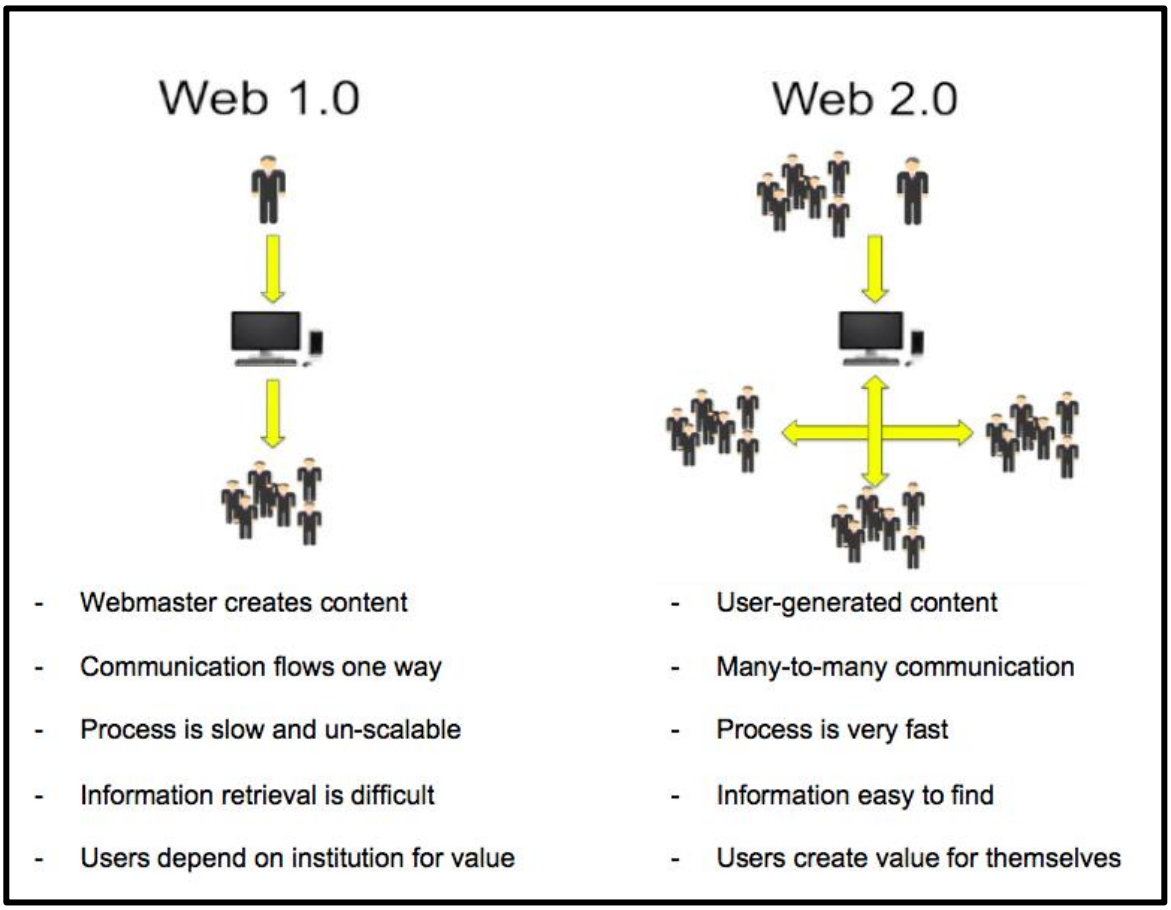

Figure 5. Web 1.0 vs. Web 2.0

The value of Web 2.0 websites is a direct byproduct of interaction between users sharing their individual knowledge or designs such that any other user in the group can add to it and advance it towards something greater. Wikipedia articles, as one example, are the result of a back-and-forth conversation between users openly adding their content and editing that of others to provide a source of knowledge enabling everyone who uses Wikipedia to benefit.

63 Anklam, *Net Work*, 223.

As a result of these characteristics, Web 2.0 websites produce value for all of its participants based on what is known as "user-generated content." This term does not simply denote content created by users, as the name might suggest, but places greater emphasis on the capability for users to re-create, recycle and enrich the content of other users in an iterative and interactive way.[64] User-generated content is that created by users working together and openly sharing the latest remix or mash up of ideas and content to make something new and better. Due to the transparent nature of these websites, anyone can participate in the process of creating value, even in fields once exclusively held by professionals, for example journalism. However, the amateurization and informal processes associated with Web 2.0 are perhaps misleading as they suggest a substandard output. The heretofore conclusion has been that amateur production is subpar to that produced by professionals in analogous fields. However, Web 2.0 suggests something different. The resulting output of Web 2.0 websites, comprised of amateurs (and some professionals), is often more robust, contains fewer errors, and is produced with far less time to market than those produced exclusively by professionals, as the user-generated Wikipedia and Linux demonstrate.[65] As a credit to Web 2.0's success, by 2007, the English-language Wikipedia "was the only noncommercial site in the top 20 websites for the United States and Linux currently runs 40 percent of the world's servers."[66]

3. The Value of Web 2.0 Platforms in Combatting Information Overload

Collaborative web portals combine the production aspects of small group information processing and computer algorithms as well as the horizontally integrated infrastructure that makes possible the massive sharing of thoughts and ideas. With these qualities in mind, Web 2.0 is a holistic approach to the information overload dilemma. Taking this thought even deeper, we can see information as the brick and mortar of our mental processes and the better we are at managing it—through computer algorithms, collaborative processes, and an organizational redesign that enables sharing of thoughts

64 Shirky, *Here Comes Everybody*, 83.

65 Ibid.

66 Ibid., 114.

and ideas—the better our potential to cultivate knowledge. Increasing our cognitive potential makes for better decision making, a faster turnaround on policies and doctrine, and an all-around smoother operation of military organizations.

a. Mesh Network Principles

Perhaps the greatest value afforded by Web 2.0 is its ability to enable groups of people to make sense of and develop solutions within an incredibly complex environment. The reason for this robustness comes from the fact that Web 2.0 designs create, in network parlance, a "mesh" network. A mesh network is a decentralized and distributed one in which all of the members of the network have equal access to all of the other members (and their tacit knowledge) in the network, or nearly so.[67] As a result, such a network becomes "a well-connected, trusting, and fluid [one that] has access to the generative and creative abilities" of all of its members, making "the sum ever so much more than its parts" as it acts like a networked brain.[68] As mesh networks, Web 2.0 websites foster collective intelligence by harvesting the diversity of knowledge of the members, enabling highly generative discourse and sense-making capability.[69] Based on the network's ability to self-organize around a problem and self-order the contributions of the whole, an order emerges directly as a product of the many interactions between members in the form of a "pattern, a decision, a structure, or a change in direction.""[70] Additionally, users are not forced to participate in Web 2.0 websites. They do so because they want to, and that desire means that users who participate are more likely to provide greater inputs than others in traditional environments who are obligated to perform tasks.

b. Knowledge Management Principles

In 1845, Edgar Allen Poe observed the following:

> The enormous multiplication of books in every branch of knowledge is one of the greatest evils of this age; since it presents one of the most

67 Ibid., 54.

68 Ibid., 26.

69 Miller, *The Smart Swarm*, 39.

70 Ibid., 29.

> serious obstacles to the acquisition of correct information by throwing in the reader's way piles of lumber in which he must painfully grope for the scraps of useful lumber.[71]

Before we can implement policy and solve problems, it is imperative first to understand the environment within which we are operating. However, in order to do so, we must distill from multiple human observations and intelligence, surveillance, and reconnaissance (ISR) sensors the relevant information pertinent to decision making and then process that information into actionable knowledge. The problem with the current means to process information is that it has become practically impossible since production of information is now so cheap and prolific—there is now more information in existence than we can ever hope to screen entirely to retrieve that which is relevant to our goals. The fact that Poe identified this problem in 1845, well before the Internet, strongly intimates by how many orders of magnitude the problem has been compounded. The processes of "sense making" within an ever-growing complex environment, therefore "requires skills beyond [mere] mechanical approaches; it must be deeply participatory." According to Clay Shirky, knowledge management and sense-making needs to be "collaborative, open, and transparent, using the diverse skills, talents, knowledge, and perspectives of all stakeholders" if we are to act and approach decision making knowledgeably.[72] The reason for this dialectic shift is due to the fact that the modern information landscape has evolved beyond the capability of individuals to single-handedly process all of the data required to make knowledgeable decisions within a finite time period—the ability to fully understand the dynamics of complex environments therefore necessitates a networked approach.

Scott Klososky refers to the illusion where leaders believe they have access to all knowledge in their organization available to them as Data Hubris.[73] Data Hubris reinforces the notion that no organization knows all that it knows, that is, no individual has all of the knowledge that resides inside of silos and stovepipes within their

71 Shirky, *Cognitive Surplus*, 47.

72 Ibid., 239.

73 Ibid., 89.

organization, despite what they may think. Klososky gauges that most organizations only utilize 60 percent of the knowledge that they already have stored away on servers, in documents, and the like.[74] He counters that institutional knowledge must be collected by members of the organization and communicated openly before it can be understood and have any value to the organization as a whole, namely by those in leadership positions. However, valuable knowledge is often hoarded by individuals who believe their monopoly of it affords them an advantage; or the organization does not provide an effective infrastructure through which knowledge can be transferred in the first place. Web 2.0 is an infrastructure that augments knowledge flow. A far cry from the inefficient nature of e-mail, Klososky argues that an automated means to create lists of people to whom certain types of knowledge can be passed within the organization is the best method—Web 2.0 is one such technique.[75]

Web 2.0 is extremely well suited for sharing knowledge. Klososky notes, "it [Web 2.0] is the simplest and most efficient way known to man to communicate with others."[76] By improving the ability for individuals to communicate within an organization, and across organizations, it also increases what the organization as a whole is capable of and it creates new opportunities for providing value.[77] As such, communities of practice can form spontaneously and sustain their knowledge sharing through mass interaction; their members can "recruit one another or allow themselves to be found by interested searchers."[78] Etienne Wenger, renowned expert in this field,

74 Ibid., 106.

75 Ibid., 98.

76 Ibid., 221.

77 Shirky, *Here Comes Everybody*, 171.

78 Ibid., 101.

defines communities of practice as "groups of people informally bound together by shared experience and passion for a joint enterprise" where the primary output is knowledge.[79]

Through the massively interactive forum, Web 2.0 users can educate themselves on tacit knowledge not covered, or ill communicated by official doctrine. Unlike explicit knowledge that is suited for doctrine, tacit or experiential knowledge—for example how to ride a bike—is far better communicated through a two-way conversation aided by visual and audial media. By holding discussions and posting pictures and videos, users can better communicate their experiences and innovative solutions, and they can do so without any facilitation on the part of their institutions. Thus, the users are able to create value for themselves while simultaneously eliminating the dependence on their organizations to make this learning possible.[80] Within the military, this is an absolute force multiplier because it allows the users to collectively shed light on the shadows cast by incomplete or less-than-timely knowledge procurement and training. The participants of the community of practice become students and teachers, whereas traditional knowledge procurement methods maintain consumers as students only.

c. Independent Value Creation

While the tangible benefits of Web 2.0 in fostering collective intelligence and enabling more efficient knowledge flow are easily identifiable, the intangible benefit of Web 2.0 in creating structural, social, and human capital is also a critical element in generating value for the network. While not always apparent, the intangible benefits of enriching knowledge within a specific domain, as well as the learned experience of creating value by participating in a community of practice, lends structural capital—users learn new ways to provide value for themselves and this sparks more participation in the future. We know this to be true because the incentive to participate comes from the intangible social values of "recognition, acknowledgment, and reputation" as well as the

79 Etienne Wenger and William Snyder, "Communities of Practice: The Organizational Frontier," *Harvard Business Review*, (Jan–Feb 2000), http://hbr.org/2000/01/communities-of-practice-the-organizational-frontier/ar/1

80 Shirky, *Here Comes Everybody*, 101.

human capital of acquiring new knowledge and skill enhancement.[81] To be sure, participation in Web 2.0 collaborative portals is not purely altruistic; "the person who teaches learns twice, the person who answers questions gets an improved reputation in the community, and the overall pattern of distributed and delayed payback" generates social capital upon which future value is made possible.[82] The more individuals participate and contribute content to collaborative websites, the greater their potential to pull value from the website in the future. As such, individuals are incentivized to sustain and even increase participation on the grounds that their potential to extract value from the website in the future will improve over time so long as others are also participating.

A relevant example revealing the nascent power of Web 2.0 to create value for users independent of traditional hierarchical institutions can be observed in the aftermath of the massive earthquake that struck near Port-au-Prince, Haiti in 2010. Two major state agencies—the U.S. Army National Guard and Red Cross—were largely ineffectual at rendering aid to those in need; their efforts were disjointed and the level of interagency coordination was incommensurate to what was required.[83] As unlikely as it may be, the hero in that disaster was a Kenyan relief-mapping blogging website called Ushahidi, which collected thousands of emails, tweets, and text messages from around the world and then used geospatial technology to identify where aid was needed and what aid was required. The website afforded users online tools to identify the nature of the their emergency, the aid they required, and their exact location. Through external volunteer efforts of self-recruited citizens on the web to mine the data and translate the messages (many were in Kreyòl), users from around the world using Ushahidi were able to "categorize and geo-locate urgent life-and-death text messages in real-time."[84] In hours, Ushahidi was able to help thousands of victims that would have taken other agencies

81 Anklam, *Net Work*, 119.

82 Shirky, *Here Comes Everybody*, 258.

83 Don Tapscott and Anthony D. Williams, *Macrowikinomics: Rebooting Business and the World* (New York: Portfolio Penguin, 2010), 4.

84 Ibid., 5.

days.[85] The irony is that the help in one fragile state's problem came not from an institution or government agency, but from thousands of distributed users collaborating together on a website.

Ushahidi is only one example of a Web 2.0 technology that allows individuals with a common goal to collaborate to create value for themselves, but it illustrates some key points on how it can be replicated. First, through the use of Internet technology, users around the world can self-recruit, self-organize, and help themselves to fix their own problems often times better than their hierarchical counterparts. Second, through the use of online tools, the Internet allows people on a global scale to not only provide ideas and solutions, but also affords them the ability to articulate how problems are affecting them personally and how they should be solved. In this way, globally distributed users can cultivate and establish precedence for a bottom-up solution process yielding far better results than the narrow-focused top-down solutions provided by states and policymakers who will never understand the nature of problems as intimately as those living at ground zero with it every day.

4. Drawbacks and Limitations of Web 2.0 Platforms

While Web 2.0 technologies can afford organizations tremendous benefits and rewards in both collective intelligence and knowledge flow, implementing such technology does not come without its own set of unique challenges and pitfalls. One challenge from a leadership perspective is the difficulty in inspiring others through a virtual environment, often from great distances.[86] In a virtual environment, leaders are unable to be heard physically and cannot make eye contact with others. While this may seem trivial, it is actually a huge barrier because it in turn hinders participants from

85 Ibid.

86 Klososky, *The Velocity Manifesto*, 244.

building trust with each other as easily as face-to-face interactions.[87] Being creative is also a challenge in a virtual space because participants do not share a common physical place to "integrate and expand on others' ideas."[88]

Online networks also require careful facilitation because participants have equal ability to share and communicate, but they are not equal—individuals differ with respect to how they communicate, their cultural backgrounds, and computer literacy. Moderators are therefore necessary to exemplify good practices and order user interaction by "keeping the conversation on topic, trying to keep the conversation from being dominated by one or two people, admonishing or removing members who use inappropriate language" and so forth.[89] It is therefore a challenge to not only determine the correct governance for the website but also in soliciting qualified personnel to take on those roles and responsibilities within the virtual network to enforce it.

Another potential downside to Web 2.0 technology is the difficulty in predicting and governing group behavior. While groups can often times come together to manifest many positive outcomes, such deleterious effects as groupthink are also possible. Peter Miller identifies a similar trait he calls "adaptive mimicking," wherein individuals in a group become hyper-focused on the signals of others—"where they are going and what they know." This leads to a vicious cycle in which individual's behavior influences the group's behavior, which in turn influences individuals' behavior ad infinitum. Miller evokes the way in which grasshoppers, agitated by contact with their hind legs, are more likely to make contact with other grasshoppers' hind legs, thereby creating the catalyst for a frenzied plague.[90] Similarly, participants of collaborative web portals can be influenced by the conduct and inputs of others such that they may act in ways that are damaging to the organization. While appropriate governance and a strong professional organizational culture can curb such behaviors, adaptive mimicking nevertheless remains a challenge for massively collaborative environments.

87 Ibid., 246.

88 Ibid., 245; Anklam, *Net Work*, 87.

89 Anklam, *Net Work*, 85.

90 Miller, *The Smart Swarm*, 162–3.

C. EXAMPLES OF COLLABORATIVE WEB PORTALS

Collaborative web portals are highly nuanced. One obvious reason for this is that not all collaborative web portals serve the same purposes or attract people with the same motivations. Indeed, many advertised 'collaborative' web portals fail to offer visitors anything more than a place to upload and store documents, which is a far cry from a portal that provides any kind of intellectual interaction between two or more people and certainly does not facilitate any massive collaboration. As Keith Hopper observes, collaborative web portals exist sometimes to solicit individual contribution and at other times "aggregate collective value," but few succeed in combining both to "[move] participation towards meaningful and intelligent results."[91]

These two kinds of collaborative web portals reflect a dichotomy. On one end is a website that solicits discreet individual inputs, but has little to show by way of complex cognitive output. An example of this is Wikipedia, or its counterpart on the Secret Internet Protocol Router (SIPR) network, Intelipedia. While these sites are great successes at collecting encyclopedic entries, and at outsourcing the quality assurance thereof, the result is an aggregate of many individually contributed, "semi-hermetic" inputs.[92] As a result, the output is not greater than the sum of its parts, but rather is exactly equal to the sum of its parts. We might think of this model as a really large building built entirely out of tiny, individual bricks. In one sense, we appreciate the size of the building because it is big, and we can conceptualize how much time it would take us working alone to stack all the bricks. Yet, in another sense, we understand that a brick alone is not substantial and so while we appreciate the aggregate of the bricks when they are stacked together, we are not very impressed with the placement of any single brick into its discreet position within the structure.

On the opposite end of the dichotomy are websites that host online forums and "etherpads," which aim to coalesce individual contributions to a common goal or

91 Keith Hopper, "Empowering Individuals Towards Collective Online Production," in *Collective Intelligence: Creating a Prosperous World at Peace*, ed. by Mark Tovey (Oakton, VA: Earth Intelligence Network, 2008), 245.

92 "Understanding Incoma," *Incoma Project* (blog), accessed 2013 July 31, http://blog.incoma.org/understanding-incoma/

purpose, but which reach a "critical mass" rather quickly and thereafter erode into unusable chaos, and "the possibility of developing a collective intelligence disappears."[93] While these sites rarely produce an output of considerable cognitive significance, their purpose is to combine the collective inputs in a way that solves a problem or designs a product that could not be accomplished without the diversity of inputs. In this model, the outcome is greater than the sum of the parts because the individuals could not achieve the end result without others' contributions. A successful example of this type of Web 2.0 website is Local Motors, a decentralized Arizona car company that fosters a Web 2.0 website community of designers to create cars. While many users submit contributions, the end result requires the members of the group to develop a shared understanding collectively of how the pieces will complement each other and perform as a cohesive vehicular system; otherwise, their contributions will be conflicting.[94] To illustrate this point, we may look back to our building example from earlier. This time the idea is to move or create a single, monolithic building, which exists simultaneously as the single unit of its composition as opposed to being an afterthought of isolated inputs. The goal is not to stack individual contributions on top of each other, but to coordinate the contributions together such that the output is a byproduct of a cohesive group, not as the aggregate of individual contributions. The building is one solid brick, cooperatively developed in concert with individuals' contributions through a coordinated effort.

If we return to our original problem of making information useful, that is, encoding it from its current state into a meaningful resource, it can be seen that both aggregating information (small, discreet contributions) and generating new, valuable concepts and ideas therefrom are desirable. How then can individuals contribute pieces to a whole, and simultaneously, what can be done to prevent participation from becoming chaotic and unusable? The literature on this subject proposes two ways of maximizing the cognitive potential of a collaborative web portal—aligning the collective intelligence "DNA" to its purpose and the use of visual heuristics.

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93 Ibid.

94 Peter Diamandis, "The 5 Ways Local Motors Built an Online Community," *Huffington Post*, April 10, 2013, http://www.huffingtonpost.com/peter-diamandis/the-5-ways-local-motors-b_b_3056843.html

D. DESIGN CONSIDERATIONS FOR CREATING COLLABORATIVE WEB PORTALS

In "The Collective Intelligence Genome," Thomas Malone and colleagues argue that there exist four gene sets that correspond in kind with four questions pertaining to the purpose and structure of collaborative web portals: "*What* is being done? *Who* is doing it? *Why* are they doing it? And *how* is it being done?"[95] Using these four questions, Malone and his team of researchers examine 250 websites and catalogue the resultant answers as "genes."[96] Post aggregation, they noticed a variety of common patterns among the genes and called these patterns collective intelligence "genomes."[97] By identifying the combinations of genes and patterns thereof, Malone and colleagues contend that some genomes are better suited for specific purposes than others, providing rich insight for leaders and managers looking to implement a Web 2.0 framework for their website. Thus, Web 2.0 websites should be purposively designed with respect to the desired output and with an intimate understanding of the users who are to provide it. In addition, the elements of the website must be constructed and aligned properly to produce a genome congruent with the desired output of the website. As an example, Malone and colleagues present the case of Linux, the open-sourced computer operating system code started by Linus Torvalds in 1991. They identify two genomes at work for Linux—a *decision* genome and *creation* genome, each with four genes. For the create genome, the goal (the *what*) is to develop new software modules created by the crowd (the *who*). As an incentive (the *why*), users participate because they enjoy the prospect of developing code and relish the glory at having their contributions recognized by the group. The means for production to create new code (the *how*) is via online collaboration. However, the governance for the Linux website also has a genome for *deciding* which modules are accepted in the newest release (the *what*). Linus Torvalds and his trusted "lieutenants" decide what code is to be accepted (the *who*) and, like all the other users, they too do so because they share a love for open source software and enjoy credit by their peers for

95 Thomas W. Malone, Robert Laubacher and Chrysanthos Dellarocas, "The Collective Intelligence Genome," *MIT Sloan Management Review* 51, no. 3 (2010), 22.

96 Ibid.

97 Ibid., 23.

being involved in the process (the *why*). For their part, however, Linus and his lieutenants are structured in a hierarchy (the *how*).[98] The importance of Malone's and colleagues' work is the development of a model that can be applied to a given context for which a website is being designed. Using this model (see Figure 6), leaders can better identify the appropriate design considerations to align the "create" and "decide" aspects of their website.

98 Ibid., 24.

QUESTION	GENE	USEFUL WHEN ...
Who	**Crowd**	•Resources useful in performing activities are distributed widely or in places not known in advance. •Activities can be divided into pieces satisfactorily (necessary information can be shared; gaming and sabotage can be managed). •Crowds can do things cheaper, faster, with higher quality or with higher motivation.
	Hierarchy (or, Management)	•Conditions for Crowd aren't met.
Why	**Money**	•Many factors apply, too complex to list here. But there are two rules of thumb: – Appealing to Love and Glory, rather than Money, can often (but not always) reduce costs. – Providing Money and Glory can often (but not always) influence a group's direction and speed.
	Love	
	Glory	
How — Create	**Collection**	•Conditions for Crowd, *plus* ... •Activity can be divided into small pieces that can be done (mostly) independently of each other.
	Contest	•Conditions for Collection, *plus* ... •Only one (or a few) good solutions are needed.
	Collaboration	•Activity cannot be divided into small independent pieces (otherwise Collection would be better). •There are satisfactory ways of managing the dependencies among the pieces.
How — Decide	**Group Decision**	•Conditions for Crowd, *plus* ... •Everyone in the group needs to abide by the same decision
	Voting	•Conditions for Group Decision, *plus* ... •It is important for the Crowd to be committed to the decision.
	Averaging	•Conditions for Voting, *plus* ... •Decision consists of estimating a number. •Crowd has no systematic bias about estimating the number.
	Consensus	•Conditions for Voting, *plus* ... •Achieving consensus in reasonable time is feasible (group is small enough or has similar enough views).
	Prediction Market	•Decision consists of estimating a number. •Crowd has some information about estimating the number (biases and non-independent information are OK). •Some people may have (or obtain) much better information than others. •Continuously updated estimates are useful.
	Individual Decisions	•Conditions for Crowd, *plus*... • Individuals can make their own decisions.
	Market	•Conditions for Individual Decisions, *plus*... •Money is needed to motivate people to provide the necessary effort or other resources.
	Social Network	•Conditions for Individual Decisions, *plus*... •Non-monetary motivations are sufficient for people to provide the necessary effort or other resources. •Individuals find information about others' opinions useful in making their own choices.

Figure 6. Collective intelligence genome chart[99]

99 Ibid., 25.

Another development in the field of collaborative web portals that warrants discussion is the impetus for visual heuristics. One of the design challenges already identified earlier in this section is the difficulty in achieving collective merit, since discussion boards and forums rapidly exceed their own capacity because they are un-scalable. Rather than producing complex cognitive output, these web portals devolve into chaos. The discussion up until this point has centered on determining where the website should fall on the continuum from hierarchy to anarchy—that ranges from a tightly controlled website administration to no administration at all. With total control, the website risks implosion since individuals are unable to participate given the constraints.

On the other hand, with complete freedom and no ordering force, the process will erupt into disordered chaos. YouTube video comments are a good example whereby often times three or four comments down the list, the content has literally nothing to do with the video that started the thread; rather the comments devolve quickly into a form of Internet vandalism aimed to solicit a reaction or "troll" the conversation. The assumption up until now has been that the "ordering force" and the "institution" had to be one in the same. However, new software developments are emerging that allow end-users to self-organize group outputs. Zulkefli, Ha and Jo document a series of developments in which a visual ontology is incorporated into a blogging website. Using a reply graph, users on the blog or forum can choose which comments specifically they want to respond to, and they can code their response according to type—agreement for instance.[100] The result is that users can order their comments themselves and, assuming they code the comments in a mutually agreeable way, other users can navigate the discussion more efficiently by clicking on the comments they are interested in while avoiding the need to sift through others in which they are less interested. These heuristics are fundamental to the concepts of collaborative web portals because they are being designed with the end user in mind by providing them with tools to personalize their participatory experience and order the content for the group.

100 Nural Akhmal Mohd. Zulkefli, Inay Ha, and Geun-Sik Jo, "Visualization Framework of Information Map in Blog Using Ontology," in *New Challenges in Computational Collective Intelligence*, eds. Ngoc Thanh Nguyen, Radoslaw Piotr Katarzyniak, and Adam Janiak (Incheon, Korea: Springer Berlin Heidelberg, 2009), 110.

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III. DESIGN THINKING: LAUNCHING THE PROJECT

A. INTRODUCTION

In order to determine how best to use Web 2.0 to develop the U.S. EOD network, this capstone employs a design thinking methodology. Different from design as a means to manipulate structure as Galbraith and Malone use the word, this capstone defines design thinking as a creative process for problem solving and solution generation.

The chapter opens with an introduction to the Stanford University five-step design model used for the capstone. A series of design questions are next presented along with the reasoning for narrowing the focus of the capstone from mitigating information overload to designing a website for that purpose. With a website solution chosen, the chapter addresses the goal to garner greater participation from the EOD community in the creative process of designing a website. Creativity, however, requires a space for designers to interact and exchange ideas. Due to the fact that users and designers are not co-located, this capstone uses a virtual space online to facilitate the design thinking process. The chapter concludes with an explanation of how the Stanford University five-step design model is adapted to work online among distributed users.[101]

B. STANFORD UNIVERSITY DESIGN MODEL

The five-step design thinking model developed by the Hasso Plattner Institute of Design at Stanford University includes five phases: empathize, define, ideate, prototype, and test, as Figure 7 shows. While the steps are useful to follow at the outset of a design challenge, the process itself is non-linear, that is, designers are afforded freedom to move back and forth between any of the five steps, in any order, as they are inclined.[102] Additionally, prototypes are never complete and continually undergo iterations and

101 The virtual space used in the capstone is a Google+ community that is set to private and requires my approval to join. The site can nevertheless be accessed here: http://gplus.to/EODCollectiveIntelligence/

102 Ibid., 1–5.

refinements. This is not to suggest that the prototypes never emerge as solutions, but that any solution arrived at will need future refinements to keep current with changing environmental demands.

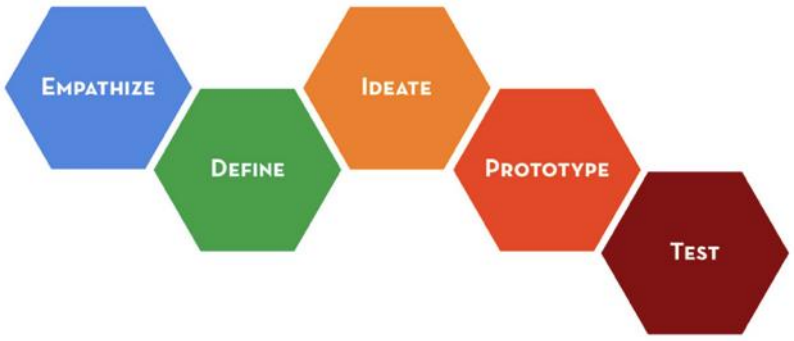

Figure 7. Stanford University Five-Step Design Model[103]

1. Empathize

During the empathize phase, designers observe users in the context of their environment and engage them in open conversations to better understand their relationship to a given problem. Learning about users in this way does more than teach designers about who their users are; it also provides designers with a strong sense of their users' underlying motivations and values, elements that designers must take into account in order to be successful.[104] By deeply immersing themselves in users' environments, designers often discover needs that users themselves may not be aware they have. Empathy is therefore a critical element of design thinking that enables designers to unlock hidden insight and wisdom.

While a dialogue with users can be conducted in many ways to elicit key insights on users' needs, a face-to-face setting is preferred. As a best practice, questions are presented to the user while maintaining eye contact in order to facilitate a natural conversation. While the designer engages the user, another records and documents the

103 Ibid., 3.

104 Ibid., 1, 10.

dialogue. A second recorder captures non-verbal cues—facial expressions, sighs, laughter, etc.—associated with the verbal responses. The use of recorders ensures that key insights are captured while enabling the designer to focus his or her complete attention on the user. Holding dialogue with users in this way allows the conversation to flow smoothly and naturally, encouraging users to remain comfortable and engaged. As a result, the empathize step is more likely to yield a rich volume of insight that greatly helps to drive the design thinking process.

2. Define

The goal of the define step is to "unpack and synthesize [designers'] empathy findings into compelling needs and insights."[105] First, the notes from the empathize step are unpacked, that is, the observations are collected and examined through the aid of a point of view (POV) map (see Figure 8).[106] The POV map aids designers by allowing them to separate different elements acquired during the empathize step in an ordered way.

105 Ibid., 2.

106 A point of view map is a four-quadrant diagram used to separate observations and key words or phrases into useful categories—say (what is said), do (actions and behaviors), think (observations/attributions), and feel (potential motivations behind words or actions); Ibid., 15

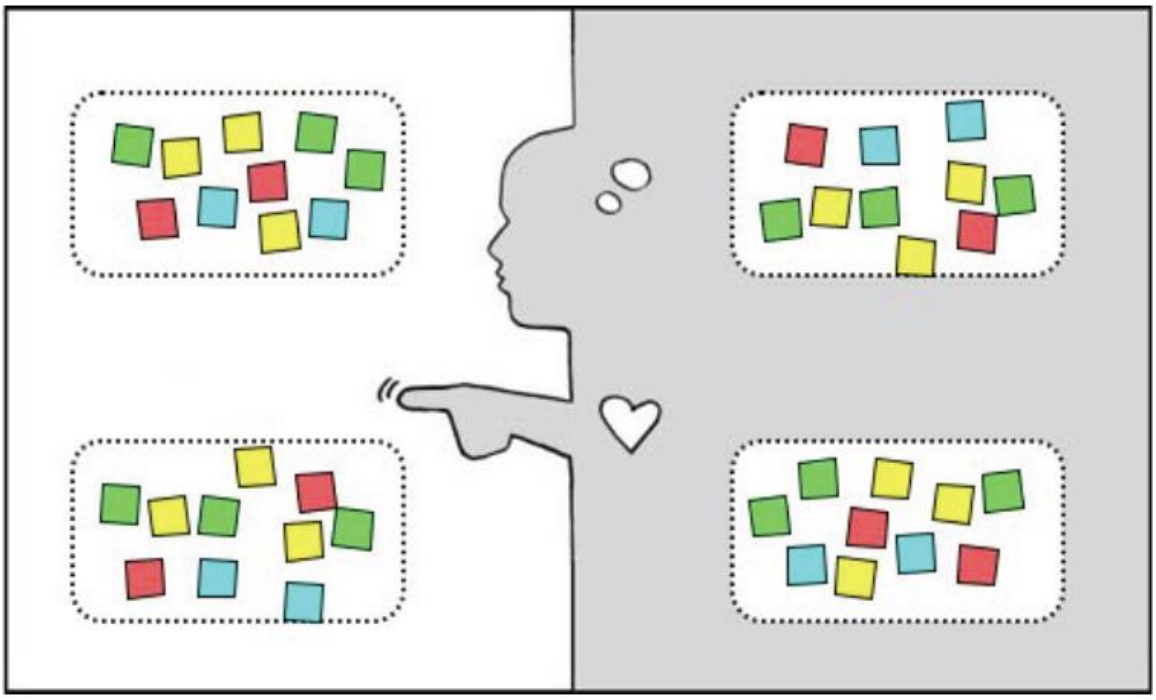

Figure 8. POV map[107]

A POV map divides the data from the empathize step into four discreet types of observations: “Say,” “Do,” “Think,” and “Feel.”[108] Beginning in the upper-left quadrant, participants post defining words and phrases spoken by the user during the conversation. The lower-left quadrant documents the users non-verbal actions—facial gestures, sighs, etc. The top-right quadrant assumes what users might be thinking and from those thoughts seeks revelation into a user’s personal beliefs. Finally, the lower-right quadrant asks designers to make educated guesses, based on a user’s actions, as to what he or she may have felt to cause those actions.

Next, designers carefully examine the map to synthesize a user needs statement. The point is to distill from the POV map the essential parts of the conversation and communicate them in a concise statement. A user needs statement is constructed in the

[107] Ibid., 15.

[108] Ibid.

following format, substituting qualifiers between the brackets: "[USER] needs [USER'S NEED] because [SURPRISING INSIGHT]."[109] A walkthrough of this process is presented later in the chapter.

3. Ideate

Where the purpose of the define step is to start with a great amount of content deduce it to a concise user needs statement, the ideate step in contrast starts with the user needs statement and expands outward in an attempt to brainstorm innovative ideas to address the user's needs. The step is therefore inductive as it moves from the specific to the general. The goal of the ideation step is to "explore a wide solution space" both in terms of quantity and diversity before narrowing them down to areas of focus.[110] During ideation, designers evolve beyond merely examining problems to actively attempting to discover solutions for them. This step derives its strength from the contributions of team members and the collective ability to draw inspiration from those inputs.[111] Ideation is also a shared and immersive visual experience; designers surround themselves with pictures or short phrases, typically written on colored sticky notes, to inspire innovative and novel solutions. The initial phase of ideation that wildly explores myriad concepts and ideas is called saturation, as shown in Figure 9 on the left.[112]

109 Ibid., 21.

110 Ibid., 3.

111 Ibid.

112 Ibid., 14.

Figure 9. Saturation and grouping phases of ideate step[113]

During saturation, designers are encouraged to write concise statements that represent an idea to address a user's need. Each designer receives his or her uniquely colored set of sticky notes that acts to reveal the author's identity. After each participant has been afforded the opportunity to post his or her ideas onto a common wall, the group progresses to the grouping phase.

The next phase in the ideate step is called grouping, as shown in Figure 9 on the right. During grouping, connections are made between contributions and joined into similar groups or categories. Each participant walks the group through their ideas, supplying additional information only when necessary. After each participant has presented the ideas on their sticky notes, they collectively propose ways to order and combine the ideas into categories and eventually suggest key relationships between the categories themselves.[114] As a result of ideation, interesting insights can be synthesized to inspire the building of prototypes.

4. Prototype

Prototyping is the physical manifestation of thoughts and ideas. During this step, designers look to rapidly build physical representations of their ideas in order to inspire

113 Ibid.

114 Ibid.

others and garner feedback from users.[115] Thus, the prototype aims to convey an experience to a user such that he or she can explore the feel and function of the solution. Figure 10 shows an example of prototyping.

Figure 10. Prototype example[116]

Due to the fact that designers are *encouraged* to fail quickly, often, and cheaply, the process has to be iterative and evolves into a kind of conversation between users and designers; hence the step is highly interactive, tolerates risk, and progresses from low to high resolution through a succession of refinements.

5. Test

The last step in the Stanford model involves testing prototypes and solutions with users. Ideally, testing and prototyping go hand-in-hand and iteratively inform the other many times throughout the design process. The purpose of testing is to acquire valuable

115 Ibid., 4.

116 Ibid., 34.

feedback from users on the applicability and effectiveness of a prototype for solving a given problem.[117] Thus, testing in design terms is very different from traditional methods in that people are not test subjects. Rather, the prototype is what is being tested and the standard by which it is judged is the feedback from users. Through iterative testing, adjustments can be made to improve prototype functionality. Only after functionality is sufficiently validated should prototypes be developed with higher resolution and specificity.

The following section presents the evolution of the design questions asked during the capstone and the ultimate design challenge that designers use to develop the Web 2.0 website prototype for the U.S. EOD community.

C. EOD COMMUNITY DESIGN CHALLENGE

The capstone originated from my experiences as an EOD officer deployed to Combined Joint Task Force Horn of Africa (CJTF HOA) and feeling frustrated at the difficulty in acquiring relevant knowledge and finding people in key positions to provide that knowledge. After returning from deployment and arriving at Naval Postgraduate School in Monterey, CA, a conversation with a peer led to the realization that the problems I experienced were not uniquely my own, but rather they are endemic to EOD operators everywhere who often operate in geographically distributed teams.

Prior to launching the capstone and inviting members of the EOD community to assist me in the design process, I started with a broad design question posed to myself: Given the challenges faced by the EOD community, especially those caused by information overload, how might a the burden of information be lessened to better enable *naval* EOD operators to solve problems and make decisions?

1. Empathize

To answer this broad question, I started informally communicating with other officers and teammates to validate my reasons for exploring the information overload problem. I also wanted to understand the problem more fully from other EOD members'

117 Ibid., 5.

perspectives to see how their experiences differed from my own. During this time, many of those I corresponded with shared my feelings of frustration with information overload. Their comments primarily indicated irritation at having so many disparate knowledge resources to search out discreet parcels of information and a lack of access to people in key locations from whom experiential knowledge could be passed on and learned. The findings validated my initial problem definition, but they also revealed deeper dimensions to it that I had not grasped before. I therefore succeeded in understanding the problem more fully by identifying three major sources of information overload in the EOD community: lack of knowledge sharing between disparate sources (resulting in duplicated information processing), want of ability to informally network with other EOD operators (outside of formal organizational ties), and minimal collaboration between distributed teams and users.

2. Define

During this incubation period, several comments were made to me, which proved to be incredibly insightful in defining who users are, that is, who is affected by information overload in the EOD profession. Initially, I had conceived the users as being Navy EOD operators only, since my experiences with information overload were limited to that service. However, the recommendation was soon made by a peer that if we truly want to decrease the burden of information overload caused by disparate knowledge sources, often operated by non-networked institutions, we need to open up a network between *all* organizations and agencies that support EOD operations. From this insight, I was able to define users as being *all operational* EOD members of U.S. organizations and agencies. An exhaustive account of these were presented in Chapter I.

3. Ideate

During ideation, I found the task of developing actionable solutions to mitigate information overload to be daunting. I realized that the design question I had laid out for the capstone was quite broad. However, an unlikely answer presented itself after a fellow student mentioned that social media websites enable disparate users to network and share knowledge about their experiences, independent of traditional institutions—where the

best mountain bike trails are, how to install ceiling trim by yourself, who are the best professors for a given class at NPS. Being an active user of Facebook myself, I naturally saw the applicability to my design question and mused over the implications of adopting a website similar to Facebook for the EOD community. While the idea seemed promising for enabling knowledge and people to be connected in one focal point, alarmists appropriately pointed out that this solution presents a glaring risk to security, since much of EOD knowledge is sensitive. After exploring and weighing the benefits of Internet communication technologies, I decided to bound the design question to the development of a Web 2.0 website targeted for a SIPRNet domain, the government's secure Internet network.

4. Capstone Launch Decision

Bounding the limits of the problem to the new design question—how might we design a Web 2.0 website to mitigate information overload in the EOD community?—allowed me to focus efforts toward a solution that could be prototyped within the time limits imposed by the capstone. However, the design process is not meant to be executed within a vacuum and I realized that I could develop a better website if I garnered greater participation and feedback from the *whole* EOD community. Rather than design a website *for* the EOD community, I adapted my approach so that I could design a website *with* them, thereby increasing the likelihood that the website would succeed. The next section accounts for how I was able to modify the design process to work within a distributed environment.

D. DESIGN PROCESS ADAPTED FOR DISTRIBUTED ENVIRONMENT

While the new design challenge seems straightforward, *designing a website,* the coordination measures required to connect geographically distributed members of the EOD community to participate in the design process present an extra set of challenges that must accounted for: How might we facilitate the design process among users who are geographically distributed? How can we inspire participation and creativity among users

who are not in the same creative space? How might users coordinate to communicate their thoughts and ideas in a group setting? Finally, how might users be enabled to create and test the website in real time with other users?

Due to the dispersed nature of our users, this capstone incorporated a Google+ website to facilitate the Stanford five-step model. In order to eliminate the ambiguity caused by using one website to prototype another, the Google+ website will henceforth be referred to as the virtual collaborative platform (VCP) and the capstone's prototype deliverable will simply be referred to as the website. The VCP served as a focal point to recruit and connect members, teach them the design process, and provide them the proper tools to effectively participate in the design process and provide feedback on prototypes.

Early in the project, I sent many emails to leaders in EOD organizations and agencies. I communicated the purpose of the project and requested them to extend invites to EOD personnel to join our ranks on the VCP. In these emails, I also included a link to the VCP and instructions on how to request access. Once membership to the VCP was granted, users had access to documents that communicated the design process using the Stanford model, along with other media to amplify the project's aims. There were tutorial videos demonstrating conversation skills and the use of online drawing tools, explained later in this section, that were central to the design process.

Google+ was chosen to host the VCP because of its dual capacity at providing a nascent social network and sophisticated collaboration tools. Google+ offers a free video conferencing suite called "hangouts" that members of the social network can take advantage of to communicate with others. Up to 10 users can join a hangout to perform a multitude of collaborative functions. Through the aid of a plug-in menu on the left side of the hangout screen, users are presented with several options, including screen sharing and various computer drawing tools (see Figure 11).

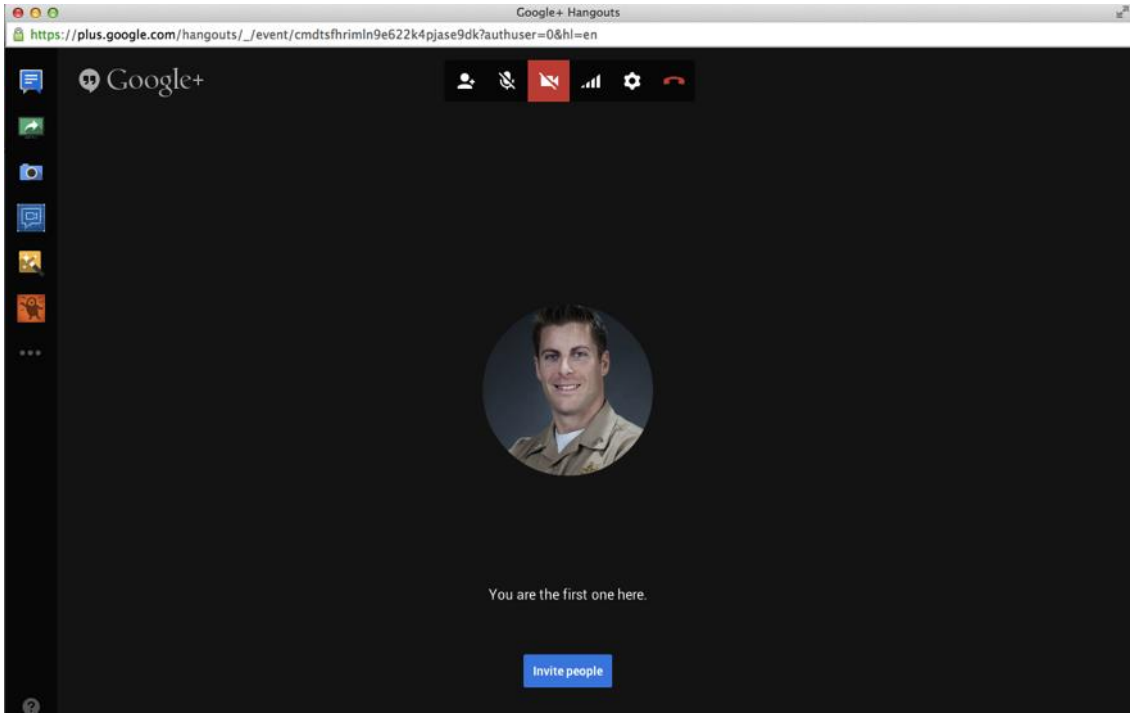

Figure 11. Hangout menu options

Participants in a hangout initially enter into a traditional videoconferencing modality in which the active speaker is displayed in a large window in the center of the screen and the feeds of all other users are displayed in smaller windows below it. When a different user begins to speak, his or her image is displayed in the larger screen, replacing the last speaker. Additional collaborative tools are accessed by clicking on their associated icon on the left of the display. Used repeatedly in this capstone is a plug-in called "Cacoo." Cacoo is initiated by clicking on the Cacoo icon, shown as the third icon from the bottom in Figure 11. Once activated, Cacoo provides all participants with a shared, real-time virtual whiteboard. A user's actions (dragging shapes around, typing text) are simultaneously conveyed on every other user's screen such that a truly collaborative environment can exist (see Figure 12).

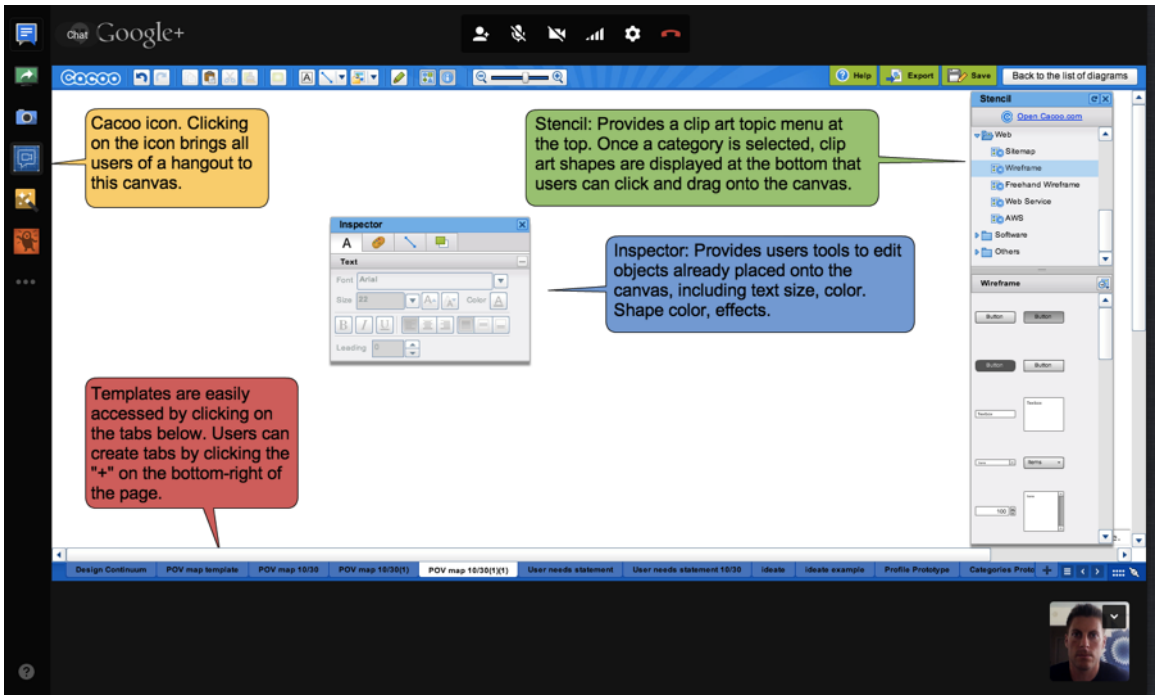

Figure 12. Cacoo collaborative canvas

Cacoo affords users multiple clip art items that they can pull from a menu to populate the canvas, as well as options to import images from a user's hard drive or the web. Designers can access myriad clipart items from the stencil menu and drag them onto the canvas. Once on the canvas, users can access the inspector to manipulate the shapes, including typing in them, resizing text, and changing the color. As well, users can continue to communicate and view each other in the small windows displayed at the bottom of the page. Cacoo was the single most important component of the VCP that enabled distributed users to create the website.

To attract participation in the design process, in September 2013, I attended the Naval C-IED Knowledge Network (NCKN) in Dahlgren, VA to announce the launch of the capstone project. The intent was to use the VCP as a creative space for the EOD community to design a Web 2.0 website. This Web 2.0 website would be developed by the EOD community to better share knowledge, informally network, and collaborate to solve problems and augment decision making. The VCP logo, shown in Figure 13, is a visual metaphor for the integrated collaboration this capstone seeks to demonstrate. The

different colored hexagons represent organizations and agencies deconstructing their boundaries in order to combine and form a hive-like infrastructure.

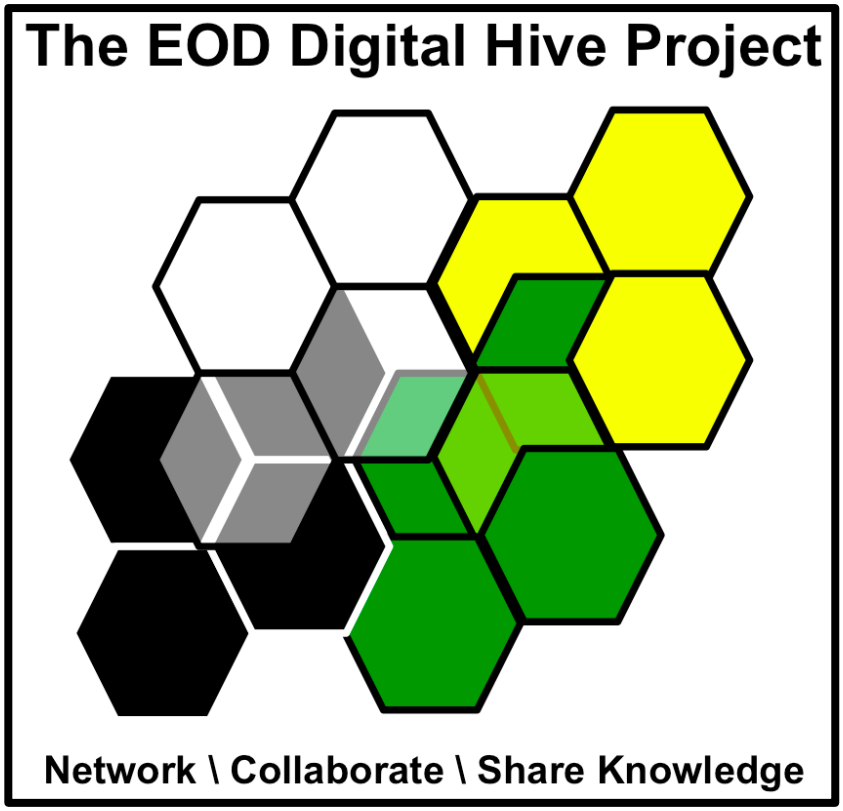

Figure 13. Google+ VCP logo

The VCP was integral to the design process. While initially it was only intended as a means to garner awareness of the project's aims, it soon became an all-inclusive means by which users could participate in every step of the design process. In essence, the VCP became a Web 2.0 platform for designing an EOD community of practice targeted for the SIPRNet. [118]

To order the elements of the VCP, the site is broken into 11 pages navigated through the use of 11 associated tabs on the left side of the webpage (see Figure 14).

118 While the intent of this capstone is to develop an EOD portal for the SIPRNet, the prototype itself does not warrant a security classification. The prototype demonstrates a construct to manage information overload, but until such time as classified content is introduced into the website, by itself the website remains unclassified with unlimited distribution.

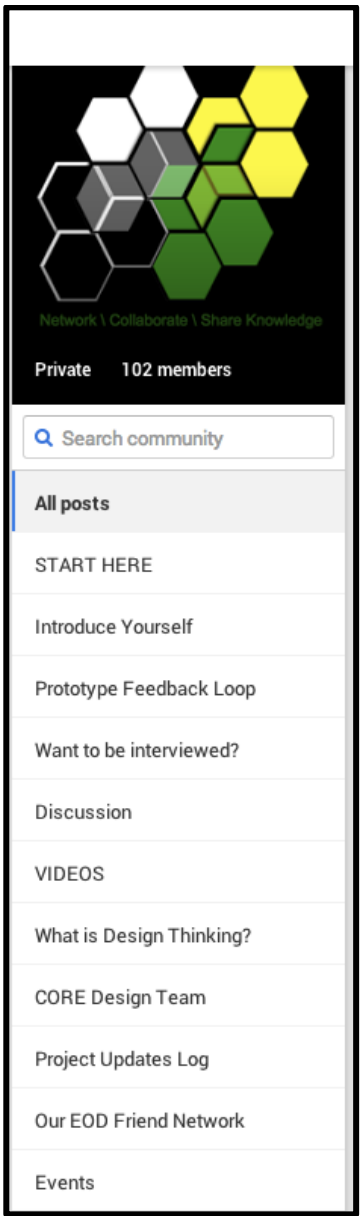

Figure 14. VCP navigation menu

The 11 pages are “START HERE,” “Introduce Yourself,” “Prototype Feedback Loop,” “Want to be interviewed?,” “Discussion,” “VIDEOS,” “What is Design Thinking?,” “CORE Design Team,” “Project Updates Log,” “Our EOD Friend Network,” and “Events.”

The “START HERE” tab is intended for first time visitors to learn the purpose of the project and explains how the site is structured. The page also explains how users can

get involved in the design process. The next tab, “Introduce yourself,” is where new users can write a post describing who they are and why they decided to join the project. The motivations surrounding users’ decisions to join the project revealed what capability vacuums existed for our users. The “Prototype Feedback Loop” is a section of the VCP where the newest iterations of the prototype website are displayed and users are invited to provide feedback in a many-to-many structured dialogue. The “Want to be interviewed?” tab provides users with a tutorial on the purpose of and methods for engaging users in conversations. It was our intent that users would find the project interesting and make themselves available so that other users could discuss their experiences with them, however, no users took advantage of this feature. The next three tabs—“Discussion,” “VIDEOS,” and “What is design thinking?”—provide forums for users to post comments in a discussion or learn about topics related to the project. The “CORE Design Team” tab provides information to users and invites them to join the project’s core design team. This team of volunteers met online approximately once every two weeks for a duration of two months. The next tab, “Project Updates Log,” provides a timeline for all project milestones, including launch date, 50 members reached date, prototype iterations, and upcoming events. The “Our EOD Friend Network” tab was developed to recognize similar EOD community ventures in the hopes of strengthening the network and illuminating similar efforts. Lastly, the “Events” tab lists the online Google+ hangouts and provides background on what was discussed and the results of the hangout for community members to see.

The goal of the VCP was to attract EOD community users and provide them with project information. The VCP also provided users an opportunity to learn about design thinking and its application to generate coping mechanisms to combat information overload. Lastly, the VCP afforded users the tools to actively participate in the website’s design. Figure 15 shows how the Stanford University five-step model was adapted to work in the Google+ environment among distributed users.

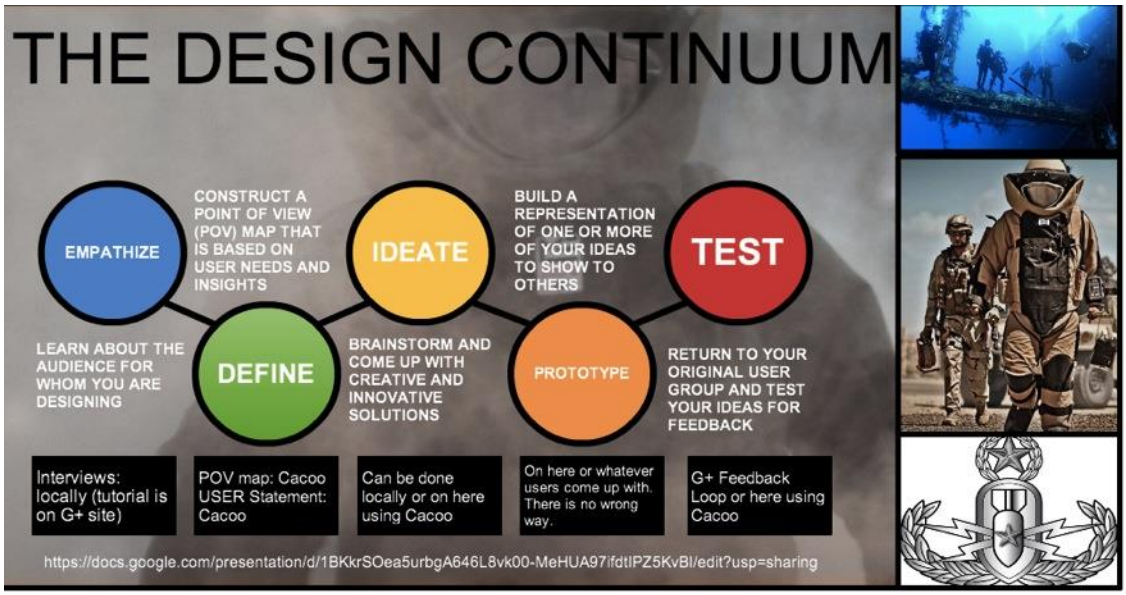

Figure 15. EOD Collective Intelligence website design process

The VCP was designed such that users working in distributed environments could collaborate to perform all five steps of the Stanford model. Figure 15 is a graphic that was displayed on the VCP homepage. It communicates to users how each step can be accomplished online. For the empathize phase, tutorials were provided on the VCP such that users could teach themselves how to hold generative discussions with users. Results of the exchanges could be posted on the VCP discussion board or users could log onto a scheduled hangout event to unpack the findings with other designers. Define and ideate were both accomplished in hangouts using Cacoo templates shared among participants' computer screens. The following sections provide a more detailed walkthrough of how the first three steps in the Stanford model (prototyping and testing are addressed in Chapter IV) were accomplished online using the VCP.

1. Empathize

This phase of the design thinking process invites members of the U.S. EOD community to communicate about themselves and their job experiences with a core team of designers. Members of the VCP network, who are U.S. EOD community stakeholders, were encouraged to provide feedback and enter into discussions on the website with each other.

Using the VCP, we invited users to provide insights as well as to contact us if they wished to enter into discussion. While the design parameters were narrowed to the creation of a website, we chose not to limit our questions to just this topic. Rather, questions focused on users' general experiences with information overload and asked them to provide details on how they managed to be successful when faced by it. Keeping our questions broad enabled us to draw insights that sometimes proved useful later when developing the website, and we would have missed valuable insights if our questions were only website related. The logic here is that by carefully listening to our users, we were sometimes able to see how our users' coping mechanisms could be applied across analogous situations. For example, if our user mentioned that he was successful in gaining knowledge by driving to the offices of an organization different than his own to speak to knowledgeable persons, we can examine if the user's tactic can be applied to a website. Perhaps it was not the driving specifically that made our user successful, but rather his ability to connect with another person who could supply him with knowledge he required. Our questions were therefore focused on the problems of information overload and not exclusively focused on our chosen web solution.

Communication with users was extremely important in the design process because not only did it provide us with incredible knowledge of the professional lives of our users, but it also kept us well-informed of our user's thoughts and opinions as we moved through the design thinking process.

During the course of the capstone, conversations were not always formally conducted. Our intent was to bring together four people in face-to-face settings when conditions, and our users, permitted. However, one challenge already identified was that the users in this capstone were not co-located with designers. Due to logistical constraints and difficulty in soliciting interested parties, we were only able to conduct one face-to-face session. Nevertheless, many users answered questions through email correspondence and posted on the VCP discussion page, providing an alternative means to gain empathy for our users.

2. Define

During hangout sessions, one user "unpacked" his or her empathy findings with the group, replacing the user's name with their rank or position to retain anonymity. Unpacking refers to the process by which the pieces conversation—verbal and non-verbal responses and implications—are extracted and inserted into a POV map for group reflection. For ease of use, a POV map template was created using Cacoo (see Figure 16) to facilitate the unpacking of findings.

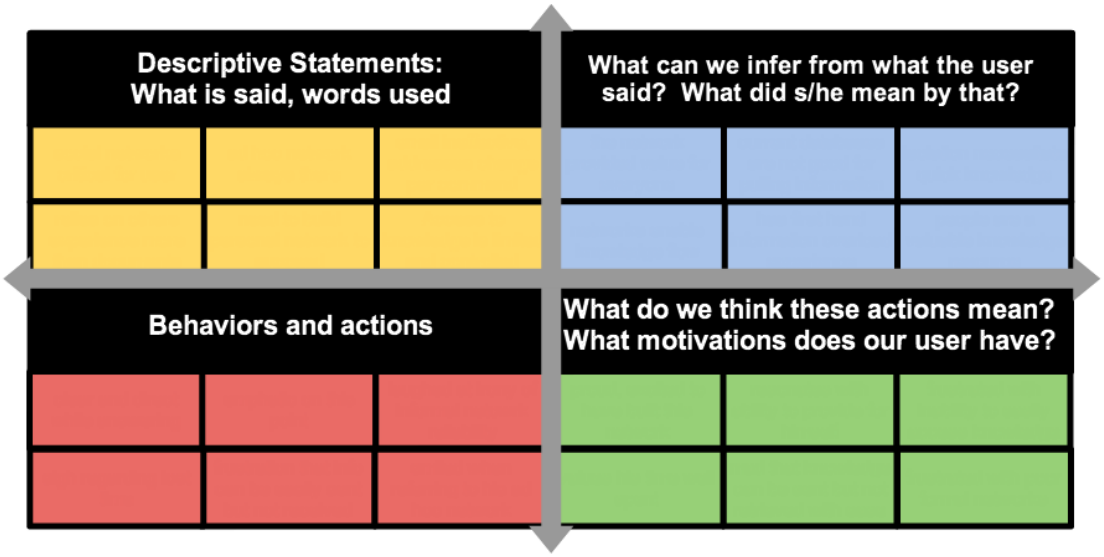

Figure 16. POV map

As designers recounted questions, answers, and non-verbal cues from the conversations with users, others typed onto virtual sticky notes in the quadrants of the POV map. The face-to-face session conducted during this capstone provides a good example of how we were able to use Cacoo to construct a POV map from the answers our user provided. Our talk with a U.S. Navy EOD officer who had just finished a tour as an EOD liaison officer provided us with a unique and rich account of the challenges he faced trying to acquire knowledge in the course of his job. As a liaison officer, it was his responsibility to provide guidance and expertise to the staff of an (aircraft) carrier strike group (CSG) on all EOD matters. Due to his isolated environment, he expressed

frustration at the difficulty of sifting through myriad paper and digital documents to find knowledge he required in a short amount of time. At the end, he revealed that an ad hoc network created among other EOD liaison officers on Facebook was extremely useful in enabling him to reach out to those in similar positions. Often those individuals participating in the ad hoc CSG EOD network had the experiential knowledge to provide undocumented solutions to each other's problems because they had encountered similar situations in the past and knew how to effectively handle them. Figure 17 depicts the POV map from this dialogue. Four question-and-answer pairs that were particularly useful are displayed at the left and bottom of the figure. The subsequent POV post-its match the color of the question-and-answer pair that prompted it. Seen side by side, the map reveals how information can be extracted and placed into its appropriate quadrant to reveal key insights into our user's needs and motivations.

Figure 17. POV map unpacking example

After unpacking these insights, we proceeded to formulate user needs statements. To facilitate this step, another Cacoo template was created such that a team of collaborators could rapidly create and discuss possible needs statements for a given users.

As an example of this step, the EOD officer mentioned earlier provided us tremendous insights into his experience as a liaison officer. His answers enabled us to

better understand his unique perspective and helped us to reframe the problem accordingly. There were elements of frustration that were captured in the conversation, both explicitly in his statements and implicitly with nods of his head, grunts and sighs when describing instances where information overload had thwarted him from performing his job. Specifically, the parts of the session that we agreed were most impactful were his expressions of annoyance at relying on antiquated and slow-moving information processing systems (publication updates, digital information databases, etc.) and a great sense of pride when reflecting on his ability to network with other EOD liaison officers via social media websites. His needs statement therefore centered on his requirement to be informally connected to other individuals with similar jobs because that approach had yielded results far superior to those of formal channels. Without his ad hoc network, our user expressed doubt that he would have been as successful in formulating effective solutions had he only used traditional and formal knowledge procurement methods. Figure 18 illustrates the user needs statement that was developed with these insights using Cacoo.

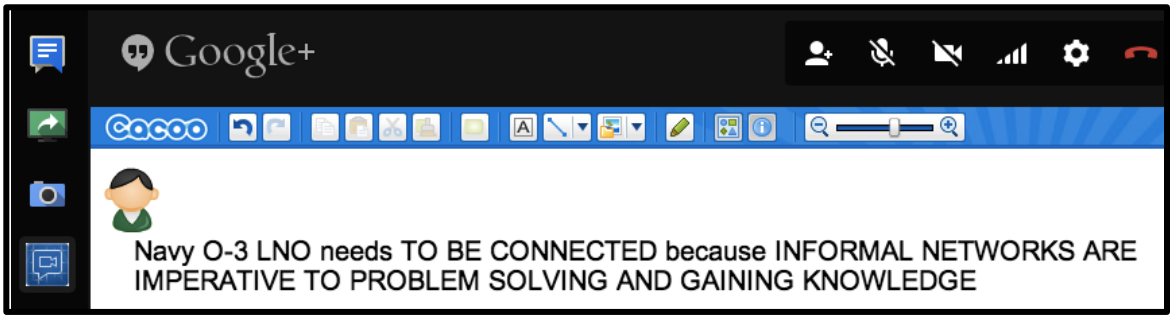

Figure 18. User needs statement using Cacoo[119]

The define step was easily accomplished using Cacoo, although often times the user needs statements resembled one another. In other words, we often found that user needs statements from the latest POV map closely resembled existing ones. From this observation, we reasoned that many of our users had similar experiences because they

119 Ibid.

consistently referenced the same vacuums where no capabilities existed for them: knowledge sharing, informal networking, and collaboration.

3. Ideate

We accomplished the ideate step of the Stanford model by incorporating a pair of Cacoo ideate templates—one for saturation and the other for grouping. Each participant in the hangout had a set of uniquely colored virtual sticky notes.[120] The initial phase of the ideate step, the saturation phase, called on participants to take a wide approach to generating ideas to prototype by typing them onto their virtual post-it notes and then dragging them onto the Cacoo canvas. These post-it comments were purposively concise, often one-word, to represent larger ideas that could be prototyped.

While traditional design methods recommend ideating onto a blank canvas for each iteration, we found it more appropriate to ideate using a running template. Core design team members, often operating on limiting time constraints, resisted ideating anew for each session and preferred instead to streamline the process by building upon past efforts. It was often the case that similar ideas would surface since many of our users had very similar user needs statements. This does not indicate a flaw in the design process, but rather signifies that many members of the EOD community are struggling with the same challenges to overcoming information overload. Our ideate efforts therefore built off of past iterations to deliver a more comprehensive range of ideas. Figure 19 presents the aggregation of ideas generated during the saturation phase.

[120] Presented in this chapter, the sequence of steps is linear because the chapter is written linearly. However, during the capstone, the steps did not always go in sequential order. For example, sometimes we would define our users and go right into prototyping or go back to the empathize step. Where in the process we went next became a product of group discussion regarding which step seemed the best for the given situation and what efforts had already been achieved in the prototyping at that point in time.

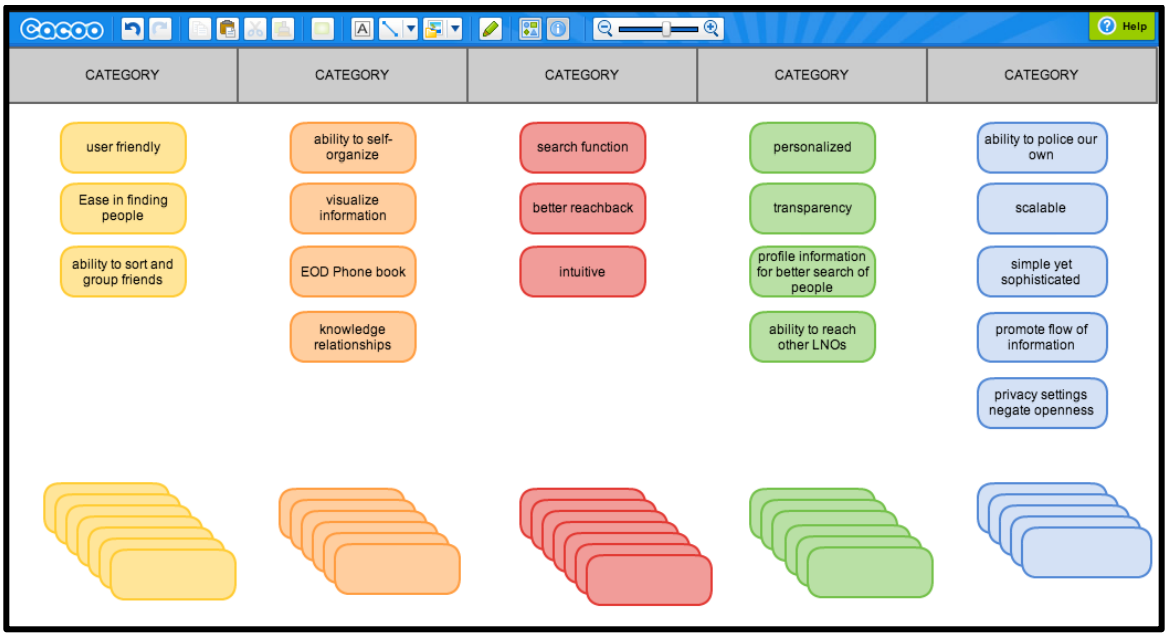

Figure 19. Saturation ideate results

In the saturation template, Figure 19, there are no categories designated. Users select virtual post-it notes from their designated stack, type their idea, and place it onto the canvas above their stack. After an appropriate length of time—it varied for each session, but usually after 15 minutes—we moved from the saturation phase into the grouping phase of ideation. During the grouping phase, ideas were grouped into categories and from there key relationships were offered to link categories together. As a result of these extra connections, we were better equipped to move into prototyping knowing what capabilities to build into the website. Figure 20 shows the results of the capstone's grouping sessions.

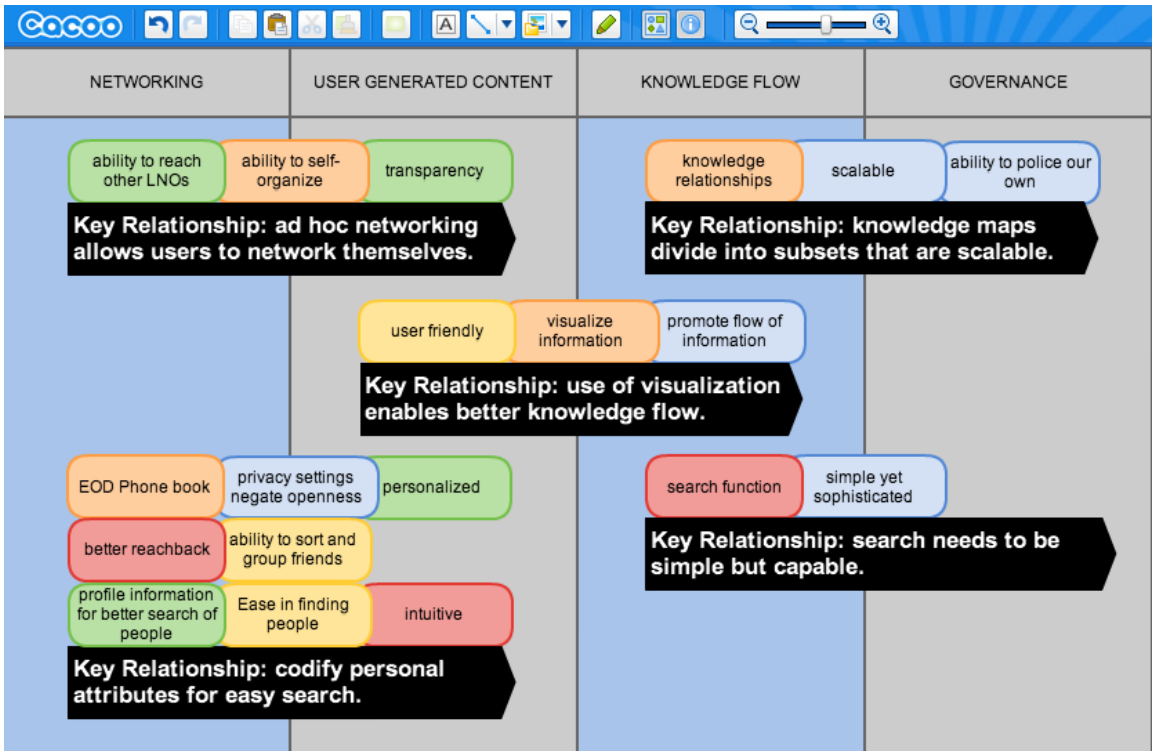

Figure 20. Grouping phase ideation results

Over the course of the capstone, the grouping phase of the ideate step ordered the ideas that were generated during the saturation phase. When the group was prepared to move from saturation to grouping, participants highlighted any newly submitted ideas on the saturation template and clicked on the "copy" button in the menu at the top of the screen. Once finished, users moved to the grouping template (Figure 20) and clicked on the "paste" icon to add the newest saturation ideas to the grouping template canvas.

Initially, we proposed and discussed categories to cluster ideas together. The four categories we decided on are "Networking," "User-generated content," "Knowledge flow," and "Governance" and are presented at the top of the vertical columns in Figure 20. The networking category coalesced around users' desires and needs to informally search out and find one another. The user-generated content category combined ideas concerning users' motivations to create value for themselves without reliance upon hierarchical institutions and the capability to tap the unfiltered knowledge pool of other EOD technicians directly without use of an intermediary. Knowledge flow grouped ideas related to our users' frustration that slow, bureaucratic processes restricted the

transference of knowledge between distributed individuals. The category therefore focused on ways to enhance knowledge flow, including visual representations and mapping techniques that users could use to communicate ideas to each other more effectively. Lastly, the category of governance was chosen to tie only a few ideas together. We nevertheless felt it important to include the category as we anticipated its importance in the prototype and future implementation.

While the categories helped us group ideas together, the later incorporation of key relationships (the horizontal black arrows in Figure 20) greatly augmented the design process. Whereas the categories serve to find commonality between individual ideas, the key relationships found connections between the categories such that the entire map of ideas became an interconnected system of actionable concepts. There are five key relationships that emerged from this capstone. First, we found that users' need to network with each other is more likely to be met if users themselves have the means to create their own networks and cultivate their own connections. In order to best accomplish this, the second key relationship states that individuals working together in the website's network must provide enough attributable information in a codified way so that users can easily search for one another and be searched for in return. Moving from user-generated content to knowledge flow, our third key relationship discovered that visual representations of knowledge simplify users' task of navigating and retrieving it. The fourth key relationship found that mapping out knowledge is intuitive for those with EOD training, since the training received categorizes explosive threats into many codified divisions already. Given the ability for users to post ideas where they think they should be posted, in accord with existing doctrine, and added with mechanisms for the group to modify poorly distributed posts, users can cultivate a viable database for themselves. Finally, the fifth key relationship identified that many users are displeased with current SIPRNet search algorithms. According to them, the search function on many SIPRNet websites either does not exist or it is too complicated for them to bother trying to learn, e.g. not user friendly. The prototype must therefore provide a simple and intuitive, yet capable, search function.

Our ability to group topics vertically by categories and horizontally by key relationships was integral to developing a sound prototype because it ensured the prototype would be designed as an integrated system of four interrelated parts. These four parts are explained in great detail in the next chapter.

IV. INITIAL PROTOTYPE ASSESSMENT AND TESTING

The previous chapter summarized the Stanford design thinking model and each of its five steps. It also documented the project from its initiation through its ideation phase and the selection of a new idea to focus efforts. The new idea is the creation and development of a Web 2.0 website for the EOD community.

This chapter documents the evolution of the website and presents its four unique parts: a profile; knowledge map; base-layer; and posts page. Results of prototype testing and subsequent redesign follow. The chapter concludes with its examination of the website using the collective intelligence genome model presented in Chapter II.

A. OVERVIEW

Through the course of this capstone project, the website underwent many evolutions and style changes. As the fourth phase of the design process, prototyping is the primary focus for this chapter and the project writ large. However, the development of the website was achieved through a close marriage between all phases of the design process. Knowing what capabilities our users desire and the frustrations they experienced provided invaluable insight for prototyping the website. The following section explores the use of the VCP to build and test the website.

1. Prototype

In designing a Web 2.0 website to aid the EOD community in coping with information overload, this project used the VCP to provide a collaborative virtual canvas to design the website. Participants selected and dragged images from a pool of website clipart items (such as universal web icons, symbols, scroll bars, text boxes, video feeds, faces, and other graphics) onto the Cacoo canvas incorporating ideas from the ideate phase. Contributors repositioned and resized images any way they liked to create the desired look of the website. During the Cacoo sessions, other participants were able to comment on, edit, and recycle the contributions of others in a highly collaborative and

communicative way. As well, changes were easily rendered through the incorporation of templates to explore a vast array of ideas and solutions. Figure 21 illustrates how Cacoo was used to design the profile page of the website.

Figure 21. Profile rendering using Cacoo

Initially, the website renderings were low-resolution mock-ups designed to generate rapid feedback from our users. Using insights generated from our conversations, POV maps, user needs statements, and ideate solutions, we built our first Cacoo website to capture the concept of a user profile. The point of these early efforts was to give us a starting point from which to convey a simple idea and solicit feedback. While not overly detailed, the website included enough components for users to identify with its intent and provide us their opinions. Over a two month period, the Cacoo website evolved into four elements to represent our knowledge visualization ideas. Each will be presented in great detail later in the chapter.

After our ideas had been fleshed out sufficiently and incorporated into the Cacoo renderings of the website, we transcribed them to HTML5. The transition to HTML5 was time-consuming and methodical, but the website maintained the same look as the Cacoo designs. The addition in this phase was the incorporation of functionality. At this point,

because changes took longer to implement and due to the added element of functionality, the website was thought to have progressed to the second iteration of prototyping. The redesign of the HTML5 website is the third. Thus, this capstone offers three discreet iterations of prototyping the website: Cacoo (no function), HTML5 (function), and HTML5 redesign (post formal testing). Cacoo represents the low resolution and rapid website rendering phase while HTML5 coding increases resolution by transitioning the website to the functional phase. In the functional phase, users are afforded an added feel for the website by enabling them to navigate between pages of the website. As a result, users received a more realistic experience by exploring the website as a system of interrelated parts. In the third phase, the capstone offers a redesign of the HTML5 website. The redesign phase addresses issues identified during formal testing and incorporates the feedback into a final effort for the capstone. The testing procedures are addressed in the following section.

2. Test

Early in the project, the website was crude and basic, but it was purposely designed this way to garner rapid feedback from the EOD community via the VCP. Our testing was informal and rapid, that is, we tested extremely simple concepts to validate moving toward higher resolution. In October 2013, a screen shot of the first website[121] (see Figure 21) was posted to the "Prototype Feedback Loop" page of the VCP to garner feedback. Soon after, fellow students were invited to join a hangout where they were shown the Cacoo website and asked to simulate rudimentary tasks such as clicking on the correct button to check their messages. In Cacoo, when a participant clicks on an object on the canvas, all other participants are visually notified via a blinking message inside that object that it is being edited and by whom. Thus, when a user clicks on any element on the canvas, all other users are instantly made aware. For initial testing, this method was very useful because not only did users show us that they could perform a task and with what speed, but users were free to talk to us and provide "in-the-moment" opinions on the usability and overall layout of the website.

[121] At this point in the capstone, the prototype consisted only of the profile page. Later in the project, the capstone expanded to include three more parts.

Another way we solicited feedback was by video recording and posting the Cacoo website building sessions on the "prototype feedback loop" page on the VCP. We were able to accomplish this for free using Apple's QuickTime video software and selecting "screen capture" as the recording mode. After recording the sessions, they were uploaded to the VCP where users could view and comment on them. Along with the videos of designers engaged in prototyping, screenshots of the website were also posted to solicit feedback. As the website progressed in resolution, users who participated in its design were invited to take part in a virtual guided tour of the latest Cacoo renderings as a way to provide additional feedback.

As the website evolved, gaining detail and resolution, we adopted more formal means to test the website with our users. The formal testing of our prototype was conducted once the website advanced from Cacoo templates to HTML5 mockups. In a sense, the formal testing marks a seminal shift in the capstone. During the Cacoo phase, prototypes were created and changed so rapidly that we did not consider them to be separate iterations (version 1, 2, etc.). The process of drawing the website in Cacoo was creative and fluid. Due to the rapidness and ease with which the website renderings were modified, the progression was smooth and flowed more like a visual conversation between designers and users than a series of discernable iterations.

During formal testing, three volunteers were given a mock scenario and a list of tasks to complete using the website (see Appendix A for the prototype benchmark results). The formal test occurred in November 2013. During this test, a facilitator was present to encourage the user to give "in-the-moment" feedback, ask questions, and to talk about their experience as the tasks were being completed. An observer was also present to time events completed by the user as well as document significant results. Following the website test[122], users were asked to complete a feedback form to capture any remaining thoughts or recommendations regarding the website design (see Appendix B for feedback form). The results of the feedback form drove our redesign for the final

122 A clear distinction must be made between prototype assessment and user evaluation. For our prototype testing, our users are not subjects. Rather, users provide the feedback by which we judge our prototype. If our users cannot perform tasks, it does not reflect poorly on them but on our prototype. For prototyping, we assume that all errors are the result of the prototype's design.

website. Using established human-computer interaction (HCI) design criteria, we tested our website on the basis of three variables—effectiveness, efficiency, and user-satisfaction.

a. Test Criteria: Effectiveness and Efficiency

Effectiveness and efficiency is ascribed to every task in which the user is asked to perform. Effectiveness is ascertained by determining if the user was able to perform the assigned task and then counting the number of errors observed during execution. Some tasks are pass/fail and rely on the user to explain the meaning of certain aspects of our website; the meaning of our legend is one example. Effectiveness is then expressed as a percentage of how many successful attempts at a task occurred for every iteration of that task. For example, if we have two users succeed at a task, but a third user made an error, we would ascribe effectiveness for that task as 66.7 percent.

If a task is completed successfully, we can determine the level of efficiency by timing how long it takes the user to succeed at the task. Success is determined by ensuring that all users take approximately the same amount of time to perform the task. For our purposes, if our users completed a task within 10 seconds of any other user, we consider the task passed with 100 percent efficiency.

b. Test Criteria: User Satisfaction

User satisfaction, or lack thereof, is determined based on users' "think aloud" comments, post-test questionnaire, body language, and audible reactions (laugh, grunt, etc.). Success for the variable of user satisfaction is achieved for an element of the website when a pattern of positive feedback is discerned. Overall success in regards to user satisfaction is therefore not determined by any one user, but based on the emerging patterns of feedback from multiple users that reveal a trend. For our limited pool of three users, this category is a bit difficult to state the results with certainty. However, it is a good baseline upon which future testing can be compared to.

c. Website Test Results

Appendix A is the effectiveness and efficiency (E&E) website test that three users helped us accomplish. This test was performed on the HTML5 website version rendered from the latest Cacoo template. Appendix B is the user feedback form that our users provided on a strictly voluntary basis. Overall, the results of our website were favorable. Our users revealed that the website was intuitive as indicated by their shared ability to complete tasks effectively and efficiently. Their comments further indicated that the website has great potential in augmenting their jobs within the EOD community. However, two considerations needed to be taken into account. First, our test was only conducted on three users. To evolve the design of the website, a greater volume of more diverse users need to test it and provide feedback. The second consideration is that the positive test results are commensurate with the resolution of the website. As our website only supports limited functionality, the assessment is limited proportionately. Before more substantial testing can occur, the website must take on greater functionality and resolution. This is to say that while summative (pre-fielding) testing is promising, the website must next undergo more formative testing to assess its functionality within the field of EOD operations.

B. WEBSITE PURPOSE

The purpose of the EOD Digital Hive website is to augment EOD community information processing and problem solving. Using Web 2.0 capabilities of many-to-many communication, the system fosters the formation of a mesh network (see Figure 22) to enable voluntary participants to transform formerly closed EOD networks into open networks among parallel EOD organizations through the sharing and building upon new ideas and timely lessons learned.

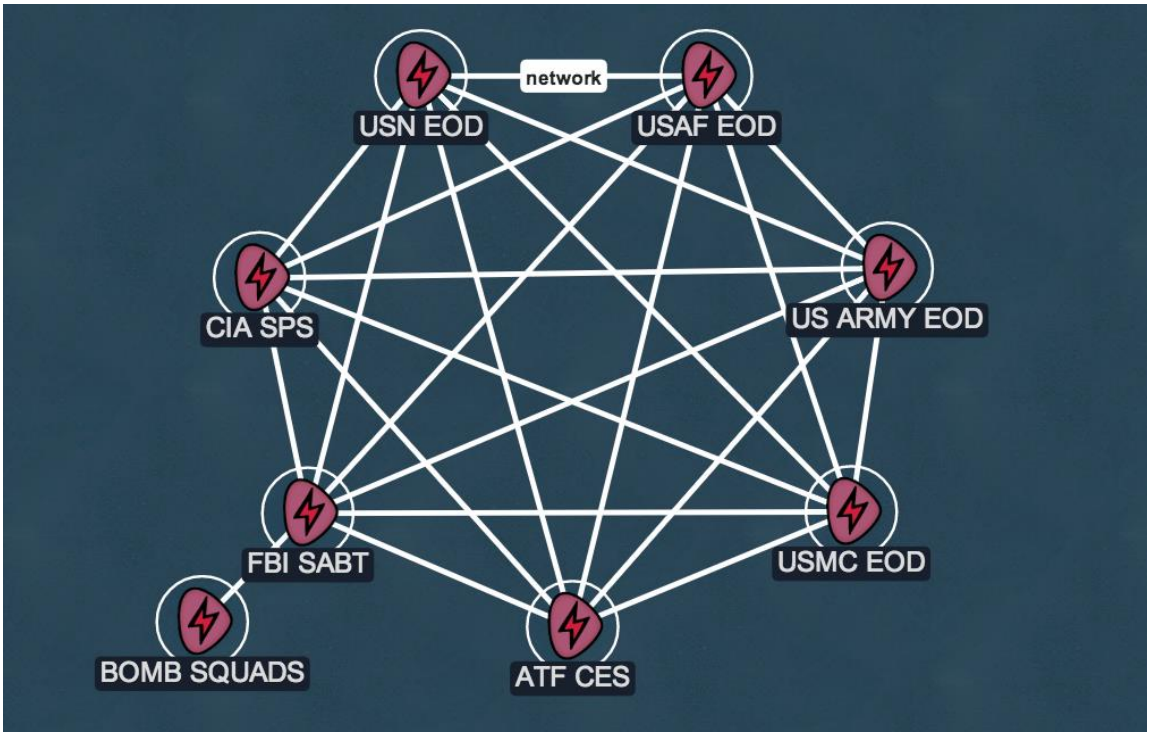

Figure 22. Mesh network of operational EOD organizations[123]

C. WEBSITE DESCRIPTION

The EOD Digital Hive website is a web-based interface designed to promote efficient sharing and retrieval of relevant information, self-organization of content, and constructive discussion among EOD personnel across all government agencies and organizations with an EOD mission. Specific features for the user include, but are not limited to:

- Adding and categorizing various forms of media (i.e., text, photos, video, audio, and all forms of data files such as pdf, doc, xls, and ppt) which are grouped based on geographic or categorically related topics.
- Viewing and commenting on media posted by other users.
- Printing pdf and other forms of media that are found on the system
- Instant and inbox messaging with other users and command representatives.

123 Nodes pictured are—U.S. Navy EOD, U.S. Army EOD, U.S. Air Force EOD, USMC EOD, FBI SABT, ATF CES, CIA SPS with a classification buffer from FBI SABT to local Bomb Squads who may or may not have congruous security clearance.

- Searching for media, users, or organizations.
- Viewing other users' profiles to review their level of expertise or knowledge, specialty, and connections with other users and organizations.
- Creating ad hoc teams or communities to collaborate on various activities.

The website is ordered into four interrelated parts—a profile page, knowledge map, base-layer, and posts page. What follows is a brief description of each of the four parts of the website along with an analysis of how they provide value and mitigate information overload. Concluding each section is a description of the website designs as they appeared during our formal testing, an accompanying graphic, and an explanation for their subsequent modification. The redesigned elements, shown first in each of the four following sections, comprise the capstone's final deliverable.

1. Profile Page

a. Description

At the forefront of our website is a profile page where users can customize and personalize their experience as well as chat in real time with other users, search out users in their circles, and quickly navigate to find knowledge (see Figure 23).

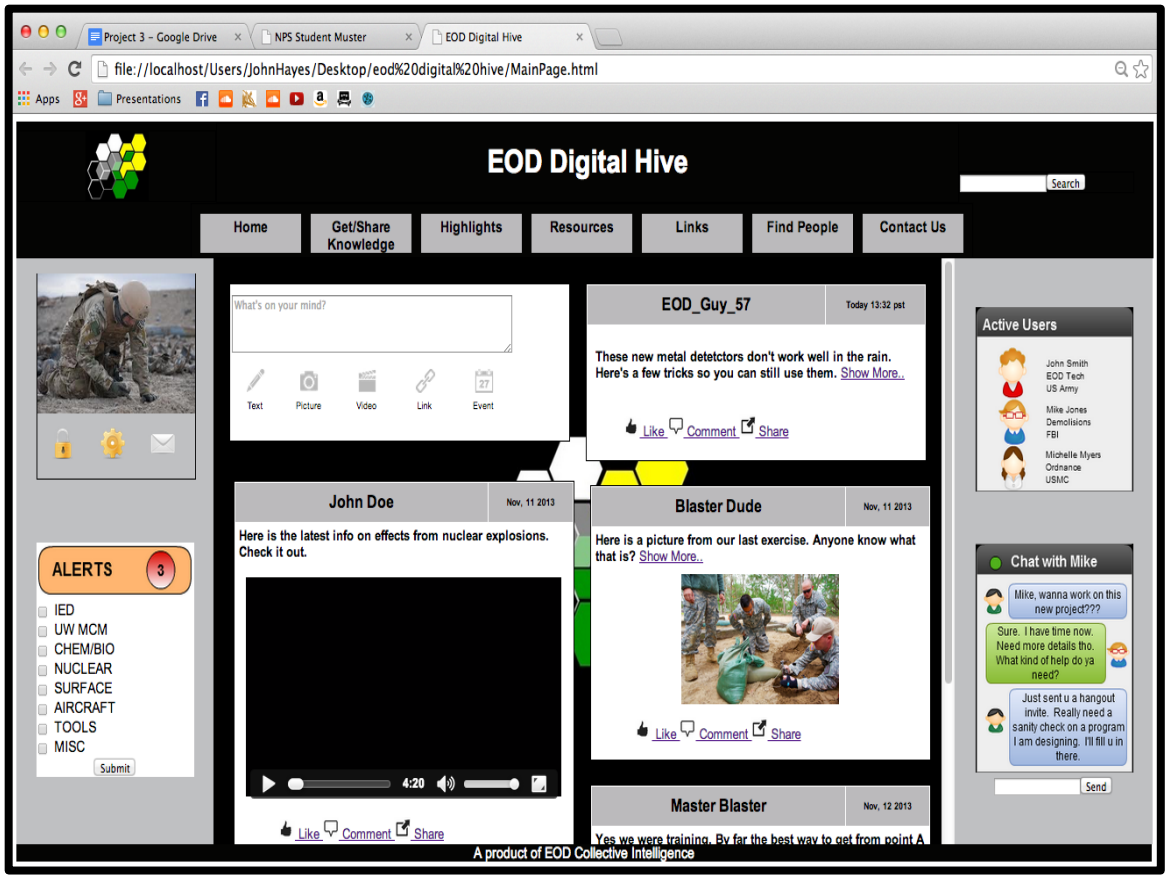

Figure 23. HTML5 profile page redesign

The use of a profile page is common in most social networking websites, such as Linked-in and Facebook, and helps attract and reward participation through the incorporation of a high degree of personalization. Users are proud of their accomplishments and the ideas they and their team develop. Through setting up their profile, users are also required to input personal information in a codified way. As a result, the information users input to create their profile allow them to be joined to ad hoc networks and facilitates the sharing among other members. The profile page is also one avenue where users can post and showcase their contributions to the community and they are rewarded by the positive comments from other users.

b. Value Added / Information Overload

In talks with our users, as documented in Chapter III, we learned that a core capability unavailable to them is the ability to easily search out others within the EOD

community. One such point of contention is the email system. Military officers especially complained of the high frequency of changing billets, such that every two years on average key positions rotate among new personnel, often resulting in a different email address. Furthermore, even for officers within a single billet, geographic deployments often necessitate a change in their assigned official email address. Therefore, it becomes a source of frustration in many community members we spoke with that they have no reliable means to locate and contact individuals in key positions. As one user put it, "there is no EOD phonebook." Therefore, another element of the profile page is a search function to find and link individuals to facilitate knowledge sharing. The benefit with our system is that once a user is linked to another user or billet (e.g., AFRICOM EOD LNO), he or she never has to search for them again. In this way, users can create ad hoc "circles," or informal networks, for and by themselves that can be sustained over time with ease and reliability. In an emergency situation where time is a limiting factor, the Digital Hive would become invaluable, especially in connecting members of different organizations who would not ordinarily come to know one other.

The profile page also addresses the information overload problem by connecting people with other people who potentially have the knowledge they will need in the future, thereby limiting the reliance on an institutionalized database—the resource here is human intelligence, not institutional, and promises the most up-to-date knowledge.

c. Impetus For Redesign

Figure 24 shows the website's profile page that we tested with the help of volunteer users.

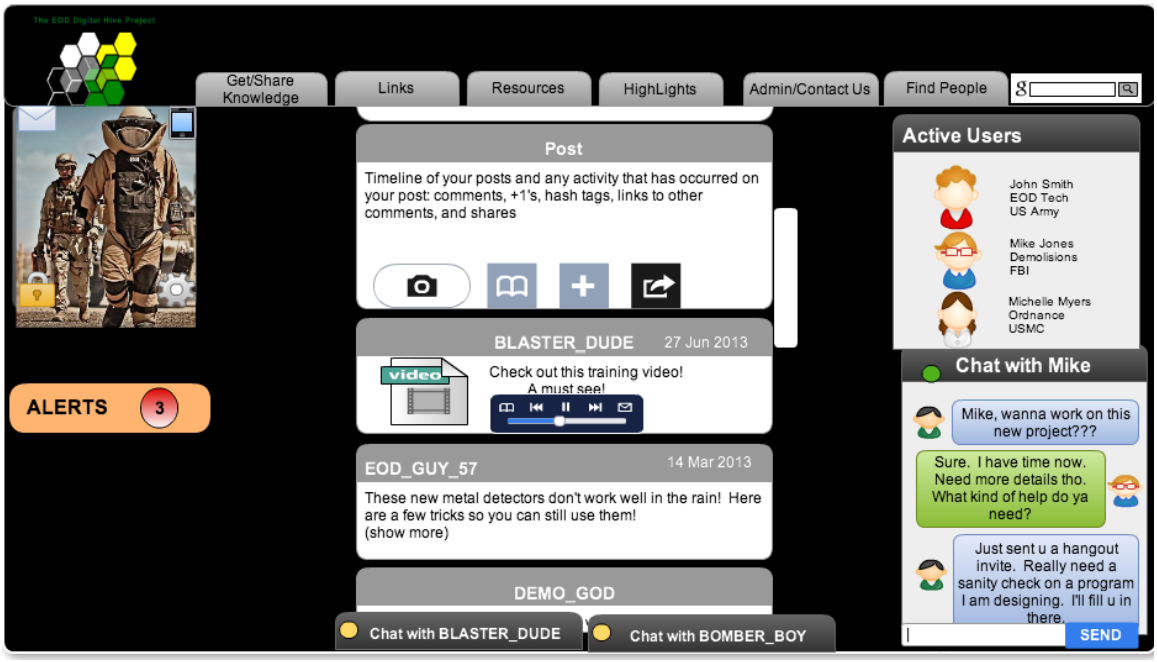

Figure 24. Profile page mockup before redesign

The biggest feedback we received from users regarding the profile page was the inefficient use of space. Prior to our redesign, we had lots of wasted space above the fold, which is the region initially displayed to a user when arriving at a webpage (below which users must scroll down to view further content). To fix this issue, we implemented two columns (instead of just one as shown in Figure 24) to represent the user's wall, that is, their most recent activity and postings as well as those they wish to view of selected friends. Ultimately, our goal with the final page was to maximize the utility with regards to space while not overburdening the user with options and complexity. Our users were very pleased with the improved layout and Appendix A reveals that tasks were performed quickly and intuitively.

2. Knowledge Map

a. Description

The second element of the website is what we call the knowledge map page (see Figure 25).

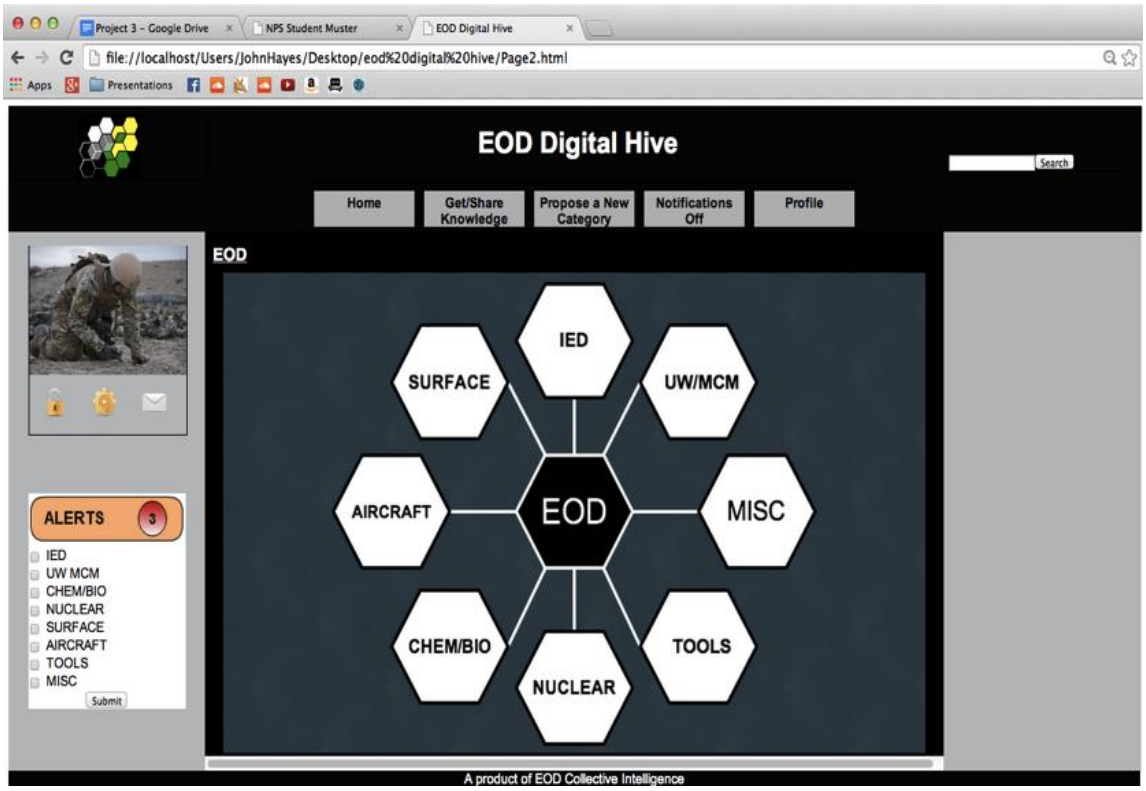

Figure 25. HTML5 knowledge map redesign prototype

The knowledge map page provides a visual typology of EOD knowledge and is broken up into the same classifications of EOD knowledge that are taught at NAVSCOLEOD, the focal point for DOD EOD training and certification. Users are brought to this page by clicking on the "Get/Share Knowledge" tab at the top of the profile page. Essentially, the knowledge map is a visual menu that places a parent topic in the center surrounded by child topics in the peripheral. In Figure 25, the parent topic "EOD" is broken into smaller sub-categories, called child topics. Assuming each of the eight child topics is evenly populated with knowledge, users can reduce the volume of knowledge they must search through by 87.5 percent by one mouse click. As users navigate the knowledge map by clicking on a child topic, the map reconfigures such that the selected child becomes the parent of its own knowledge map. Subsequently, the new parent topic sprouts child topics from which users can choose to navigate to more specific topics.

b. Value Added / Information Overload

The advantage of this mapping technique is that users can reduce the volume of knowledge they are required to search through by several orders of magnitude with only a few mouse clicks. Another advantage of using a knowledge map to navigate information is that it forces the database to be organized by layered categories. Unlike traditional list type databases, or search and retrieve databases, the knowledge map portrays everything the user wants to see on the front end and they are never overloaded with too much at any one time. Through only a few simple mouse clicks, the user can arrive at very specific knowledge domains from which they can consume, produce, or share knowledge. This process also enables users to see what the topics are called—something we feel should emerge from the group. For example, in a traditional search and retrieve database, a user might search for "pressure-cooker device" and not get any results. However, unbeknownst to her, the search for "crock pot IED" may have yielded the desired result. With our system, our user would have arrived at a set of topic cards and immediately understood which was likely to lead her to the appropriate results.

c. Impetus For Redesign

Figure 26 shows the Cacoo rendering of the knowledge map.

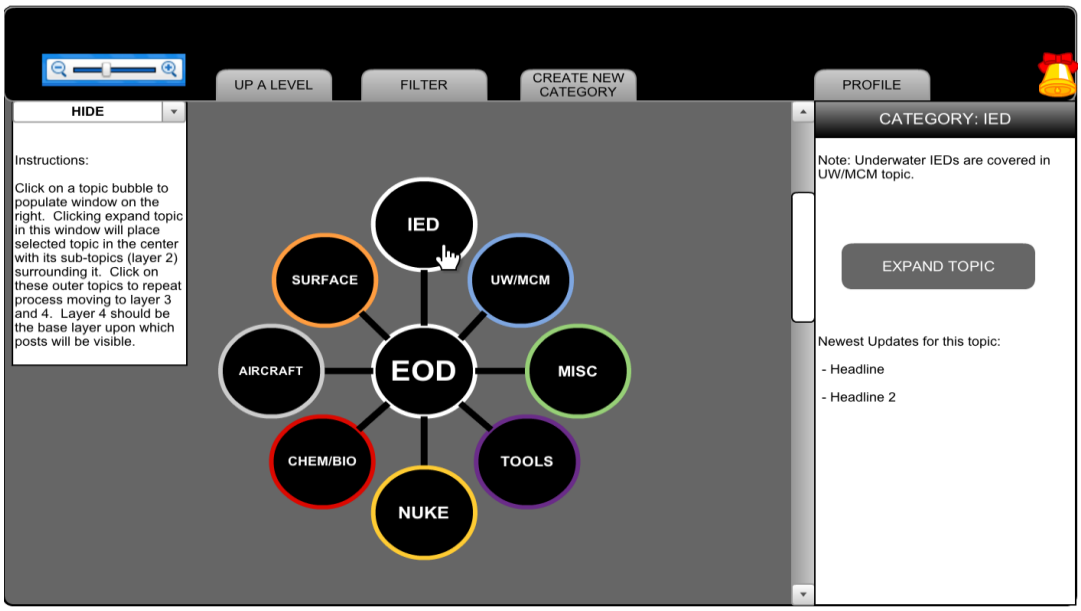

Figure 26. Cacoo knowledge map

The feedback we received indicated that the colors surrounding the topic cards (the black circles) was distracting and hinted to some kind of unknowable color-code. As well, others observed that there was no uniformity from the profile page. It was therefore decided to remove the colors in the final website as well as maintain the user's profile picture in the upper left to improve uniformity (see Figure 25 for comparison).

3. Base-Layer Page

a. Description

The base-layer page is a continuation of the knowledge map. As users proceed from the knowledge map towards topics of more specificity, after several iterations they arrive at the base-layer page (see Figure 27).

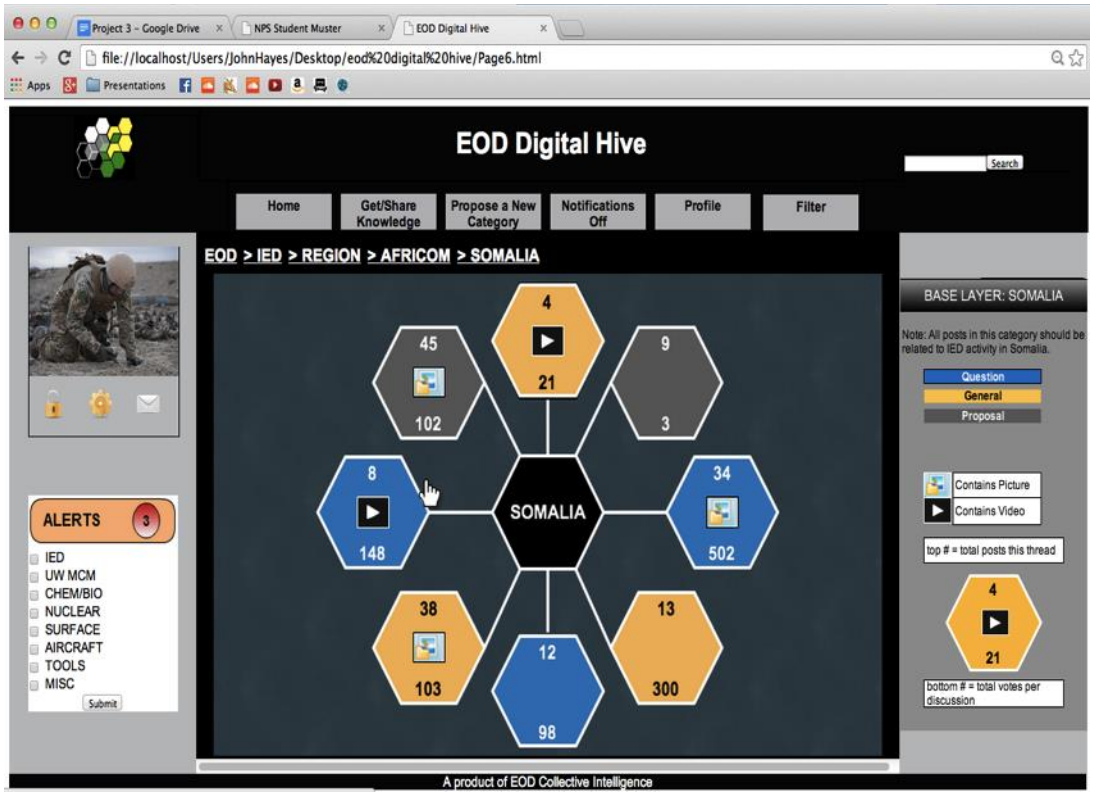

Figure 27. HTML5 base-layer redesign

What differentiates the base-layer page from the other maps in the knowledge map schema is the inability to further split the central topic. As an analogy, we might

look at the knowledge map as a body of matter that we can split up into systems, organs, tissues and cells. The base-layer then can be thought of as the atom that cannot be split any further and retain the properties of the element it constitutes. Users are made aware of reaching this base-layer level by the presence of a unique color code.

The purpose of the base-layer page is to signify to the user that there are no longer any child topics to choose from in order to refine their search. Child topics, in this instance, refer to the white hexagons that are on the outside of parent maps and represent further divisions of a parent topic (the central hexagon). As an example, Figure 27 shows the parent topic card (the black hexagon at the center of the figure), "Somalia," with no further sub-divisions, or child topics, available to it. The hexagons that are pictured adjacent to the parent topic of Somalia are not child topics because they are not white hexagons, as is the case with preceding knowledge maps. Rather, the hexagons in the outer ring in the base-layer represent conversations related to IED activity in Somalia, and the user knows this because they are not coded white. This is not to say that users cannot refine their search to further divisions of "Somalia," but in order to do so they must apply filters.

The basic underlying principle governing this page is that once users navigate through so many knowledge maps (in Figure 27, the base-layer page is reached after four knowledge maps: EOD > IED > By Region > AFRICOM) they arrive at a topic that no longer requires further division. Rather than present them with further divisions (white hexagons), users are presented with conversations (colored hexagons). The color code relates to the peripheral topic cards and notifies the user that they are a question (blue hexagon), general comment (yellow hexagon), or proposal (gray hexagon). Whereas in the knowledge maps the peripheral elements are child topics that could be clicked on to further populate a new map, on the base-layer page the peripherals are posts created by other users. The addition of universally accepted symbols also indicate the presence of multimedia content in the post—either a video or picture.

b. Value Added / Information Overload

The value added in the base-layer page is similar to the knowledge map in that users can visually seek out information. What is unique on the base-layer page is the incorporation of both a color code system and filtering option. By default, there are only a finite number of posts displayed in accordance with age—the page is biased towards the 20 newest posts. However, users can manipulate the filters to reveal posts of a single type (question, general comment, or proposal), by number of votes (this feature will be explained in the next section), as well as posts already read or not read by the user. Users also have the option to save posts to their favorites for quick retrieval. All of these options are available on this page, enabling users to quickly mine out that which is relevant to their query.

More importantly, on this page users also have the option to start a new post, thereby giving them the opportunity to ask a question, state a general comment, or propose a solution related to that particular topic. The ability to connect posts together and resolve questions based on expert and experiential knowledge sharing enables smooth navigation and promotes communal learning.

c. Impetus For Redesign

Figure 28 shows the base-layer page that we tested with our users.

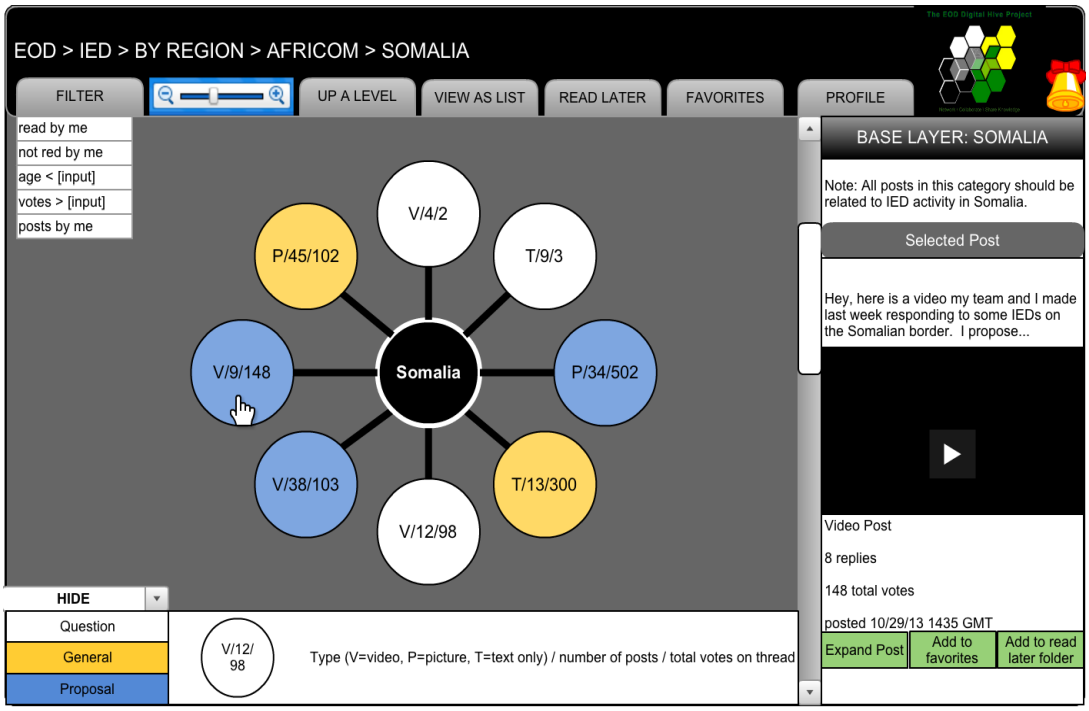

Figure 28. Cacoo base-layer page

From our users' feedback, we discovered that the legend on the bottom of the page was distracting. Initially, we thought a user might place his or her mouse over a topic and have a preview populate in the frame on the right. However, users reported that this was confusing and they preferred to click on the post directly rather than preview it. Additionally, through navigating the knowledge map users indicated it was a bit confusing where in the map they were at any given moment. We therefore implemented a navigation tracker to signify to users where in the map they currently were. For example a user on the base-layer page related to IED activity in Somalia would be able to visualize his position in the map as "EOD > IED > By Region > AFRICOM > Somalia." To make it easier for users to follow, the redesign places this information closer to the map and hyperlinks each category for easy navigation back to that parent topic.

4. Posts Page

a. Description

The posts page is a visual representation of a conversation between distributed members (see Figure 29).

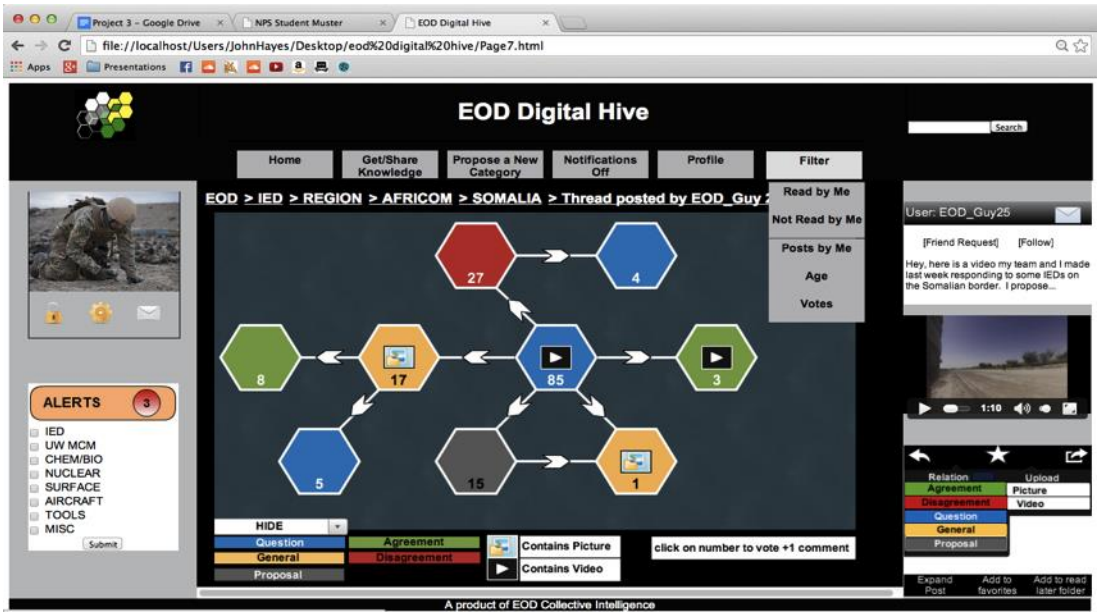

Figure 29. HTML5 posts page

Users arrive at the posts page by clicking on one of blue, yellow, or gray peripheral hexagons from the base-layer page. The initial comment, question, or proposal is represented in the center of the page. As shown in Figure 29, the blue hexagon in the center indicates a question that began the conversation. Users who are interested in that question[124] can follow the subsequent conversation by moving along the arrows directed outward from the central topic. Users also have the option to filter the conversation—for example they may only want to read questions other users have asked in the conversation, excluding general comments or proposals. Filtering topics is accomplished by clicking on the filter tab at the top of the page and selecting the desired filter method: "read by user," "not read by user," "votes threshold," and "age of post." Finally, users can participate in the conversation by clicking on any topic card within the conversation and choosing to reply to it directly or they can click its number to give it a "+1" vote. Giving comments a "+1" lends credibility to the comment. Comments can therefore emerge as credible by way of taking on the aggregate number of votes from all users who support it. The more votes, presumably the more credible and read worthy the comment.

[124] Clicking on any of the topic cards populates a text field associated with it in the upper right hand corner.

b. Value Added / Information Overload

As a visual typology, the posts page saves users time by presenting them with an intuitive heuristic by which to navigate a conversation. Unlike traditional linear conversations, our posts page offers users the ability to target any topic card in the conversation to reply to, not just the first one. As well, the users themselves choose how their comment will appear according to a color-coding chart. Similar to the color-coding system on the base-layer page, the posts page additionally affords users the additional option to code their reply based on "agreement" or "disagreement." Taken collectively, the array of color codes and incorporation of a non-linear reply graph enables users to quickly seek out aspects of a conversation they find interesting, while obviating the need to read ones they do not. Additionally, as with the base-layer page, the use of filtering allows users to display or omit elements of a conversation according to their preference.

c. Impetus For Redesign

Our users' primary concern with the posts page was the change in layout between how the previous maps looked and how the posts page map was displayed. Figure 30 shows the rectangular layout our users found confusing.

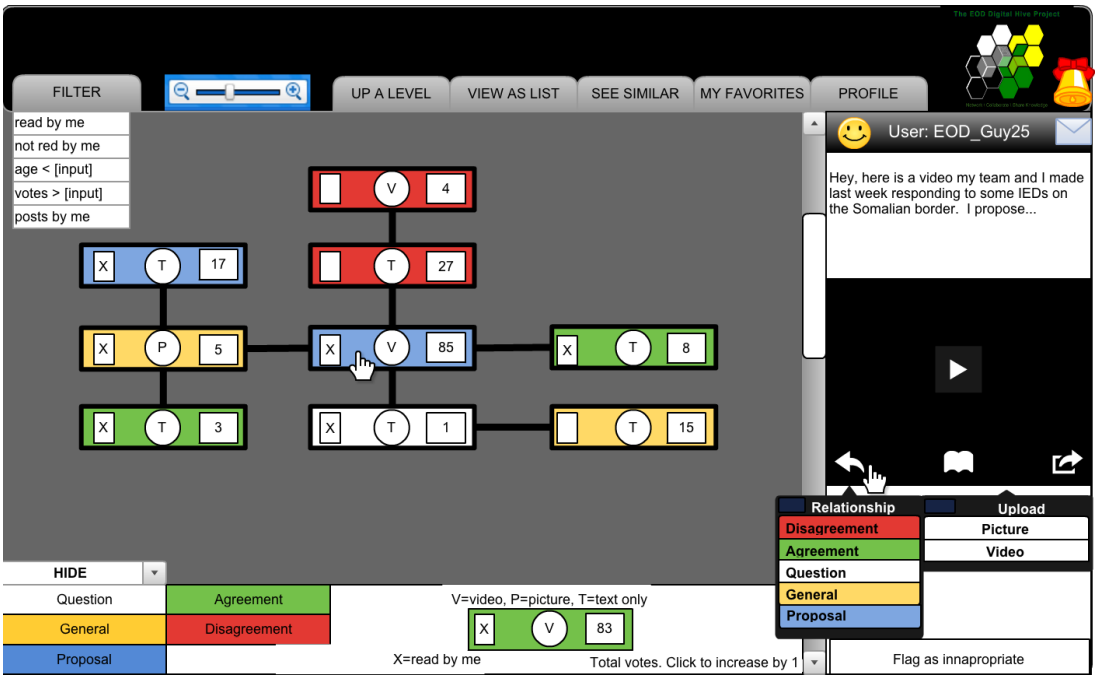

Figure 30. Cacoo posts page

Users observed that while the intent was to display the initial topic card in the center, our use of rectangles caused them to confuse it with a military organizational chart, where the flow moves from the element at the top to subordinate elements below. Therefore, we redesigned the website by incorporating hexagons. The use of hexagons affords uniformity with the previous maps along with a means to distinguish it from the organizational chart framework. Additionally, the incorporation of arrows moving outward from the initial post indicates the flow of the conversation, which our users intuitively understood in the redesigned prototype.

D. COLLECTIVE INTELLIGENCE GENOME ASSESSMENT

Designing a website to mitigate information overload is fine and well, but it begs the question how such a website will actually work. Specifically, within a multi-agency and government context, the topic of governance must be addressed and an overall relationship between who is responsible for creating the value on the website and who decides what to do with it must be identified and discussed well prior to considering implementing it. While the website is not yet at a stage where it can be operationally

employed inside existing SIPRNet infrastructure, the following offers an exploratory assessment of how the website should ultimately be structured to optimize its value creation for the EOD community.

A useful heuristic for analyzing Web 2.0 websites, developed by Malone and colleagues at the MIT Center for Collective Intelligence (presented in Chapter II), is the collective intelligence genome. For convenience, the collective intelligence genome chart is provided again in Figure 31.

QUESTION	GENE	USEFUL WHEN ...
Who	**Crowd**	•Resources useful in performing activities are distributed widely or in places not known in advance. •Activities can be divided into pieces satisfactorily (necessary information can be shared; gaming and sabotage can be managed). •Crowds can do things cheaper, faster, with higher quality or with higher motivation.
	Hierarchy (or, Management)	•Conditions for Crowd aren't met.
Why	**Money**	•Many factors apply, too complex to list here. But there are two rules of thumb: – Appealing to Love and Glory, rather than Money, can often (but not always) reduce costs. – Providing Money and Glory can often (but not always) influence a group's direction and speed.
	Love	
	Glory	
How — Create	**Collection**	•Conditions for Crowd, *plus* ... •Activity can be divided into small pieces that can be done (mostly) independently of each other.
	Contest	•Conditions for Collection, *plus* ... •Only one (or a few) good solutions are needed.
	Collaboration	•Activity cannot be divided into small independent pieces (otherwise Collection would be better). •There are satisfactory ways of managing the dependencies among the pieces.
How — Decide	**Group Decision**	•Conditions for Crowd, *plus* ... •Everyone in the group needs to abide by the same decision
	Voting	•Conditions for Group Decision, *plus* ... •It is important for the Crowd to be committed to the decision.
	Averaging	•Conditions for Voting, *plus* ... •Decision consists of estimating a number. •Crowd has no systematic bias about estimating the number.
	Consensus	•Conditions for Voting, *plus* ... •Achieving consensus in reasonable time is feasible (group is small enough or has similar enough views).
	Prediction Market	•Decision consists of estimating a number. •Crowd has some information about estimating the number (biases and non-independent information are OK). •Some people may have (or obtain) much better information than others. •Continuously updated estimates are useful.
	Individual Decisions	•Conditions for Crowd, *plus*... • Individuals can make their own decisions.
	Market	•Conditions for Individual Decisions, *plus*... •Money is needed to motivate people to provide the necessary effort or other resources.
	Social Network	•Conditions for Individual Decisions, *plus*... •Non-monetary motivations are sufficient for people to provide the necessary effort or other resources. •Individuals find information about others' opinions useful in making their own choices.

Figure 31. Collective intelligence genome chart[125]

[125] Malone et al., "The Collective Intelligence Genome," 25.

The model analyzes Web 2.0 websites according to two actions that every Web 2.0 website facilitates—*creating* value and *deciding* what is to be done about it. Accordingly, the collective intelligence genome model asks of each action: *What* is being done? *Who* is doing it? *Why* are they doing it? and *How* is it being done?[126] The answer to each question is a trait and the unique combination of traits is the genome. Figure 31 provides a comprehensive list of 16 different traits along with guidance on when they should be used or rejected. Using the list in Figure 31, we were able to develop the genome for this capstone. Figure 32 shows the Digital Hive genome. The following analysis is not an assessment of the effectiveness of the website. Rather, using the model affords future implementers of the website with a tentative evaluation of how the website should be structured to optimize its value output based on contextual considerations.

DIGITAL HIVE 	WHAT		WHO	WHY	HOW
	Create	-New knowledge -Ad Hoc Networks -User Profiles	Crowd	Love / Glory	Collection
	Decide	-What ideas are actionable -What knowledge relationships are -What knowledge becomes codified	Hierarchy	Love / Glory (Pace of operations)	Hierarchy (formal)
			Crowd		Individual Decisions (Social Network)

Figure 32. Digital Hive website collective intelligence genome chart

Without seeing the website in an operational capacity, the following analysis is mostly conjecture of how it might work and the likely governance to promote the best results for the Digital Hive website. However, through deductive reasoning and guidance provided in Figure 31, we can confidently assert which genome would best serve the EOD community. We can do this by considering three contextual elements that we

[126] Ibid., 22.

already know: What is the EOD environment? Who are the leaders in the EOD community? and who conducts EOD field operations?

The first two elements of the collective intelligence genome model, *what* and *who*, have already been addressed at great length in this capstone. It is the *why* and *how* that must be addressed in this assessment using the contextual elements presented above to select the appropriate traits. The following applies to the *create* aspects as shown in the top row of Figure 32 beneath the headings *what*, *who*, *why*, and *how* respectively. Accordingly, as the website is designed, the creation of new knowledge and ideas, cultivation of informal networks, and generation of user profiles (the *what*) would be accomplished by distributed members of the EOD community in what the model defines as the "crowd" (the *who*). In this instance the crowd refers to all members of the EOD and bomb squad professions with access to the SIPRNet and a need-to-know regarding EOD knowledge. Their participation in creating value is a result of their love and glory (the *why*). Used here, love refers to the camaraderie and esprit de corps present among members of the EOD community. Love can also denote pride in being able to work directly with others within a community of practice to learn and acquire knowledge faster than formal channels can provide. Similarly, glory refers to the possibility of being recognized for contributions on the Digital Hive.

We can assert that love and glory is the correct choice because the only other motive is money, as Figure 31 shows. Since the government is not equipped to offer cash prizes to its employees, that choice is unavailable. Therefore, by process of elimination, love and glory is chosen as the *why* trait in this assessment. The method for creating this shared value (the *how*) is collection of contributions from members to share best practices, propose solutions, and offer experiential knowledge. Collaboration, as presented in Figure 31, is not chosen because as the term is used here, collaboration is reserved for instances in which processes cannot be divided among individuals.

As with any creation generation, a dialectic engine must be properly chosen and applied to decide which created elements should be chosen and acted upon. The following addresses the *decide* aspects of the model as shown on the bottom row of Figure 32. For the Digital Hive website, the *who* and *what* decisions of what proposed

ideas should become actionable, how the knowledge map ought to be drawn, and what knowledge should become codified into doctrine falls to the existing military and civilian leadership responsible for EOD operations and the distributed EOD technicians who are likewise responsible for their respective areas of operations. But there is an important additional element present here. While EOD leadership retains the authority to accept or reject new ideas as part of their role in the codification process (hierarchy), until such time as they decide individual users should use their own judgment (crowd), as they already do offline, in deciding on solutions. Decision participation for both leaders and isolated operators is likewise promulgated by love and glory for the same reasons that were presented for the *create* row in the Digital Hive genome. There is also another reason for leadership to participate though. The pace of EOD operations, discussed in Chapter I in great detail, necessitates a networked approach to provide knowledge to the force faster than hermetic bureaucratic organizations working independently can provide. EOD Leadership is therefore motivated to participate on the website because in doing so they are better able to keep abreast of threat developments and provide value for their subordinates.

The likely means for ultimately deciding on any course of action is through use of a hierarchy (the *how*). The principle reason for this declaration is because the executive branch of the U.S. government is hierarchical by design and EOD operations are executed through a command and control structure accordingly. Decisions within the context of EOD operations are made by those in authority to make them, not voted on through a democracy. However, as a caveat to this is the notion that the Digital Hive is founded on tenets of collective intelligence in which autonomous agents have the latitude to participate in solving problems that interest them and in the ways they desire. Therefore there needs to be a balance between deciding on solutions centrally within a hierarchy and delegating autonomy to participate directly in the solution generation process. The degree to which the hierarchy exerts itself over the collective desires of participants is likely to cause tension if the degree becomes too high. In contrast, too little hierarchy involvement in decision making fails to lend credibility to the solutions developed by the crowd.

Also included in the *how/decide* block is the trait for individual decisions. According to Figure 31, when conditions for the crowd are met and individuals have the ability to make decisions, the individual decisions trait should be chosen. Isolated EOD personnel need to make their own decisions when they require solutions unavailable to them through formal knowledge channels. Additionally, the social network trait, a subset of individual decision making, is chosen because EOD personnel are likely to be very interested in their peers' opinions of their proposed solutions and the community values mentorship by experienced individuals.

Given the U.S. government context that the Digital Hive website needs to operate congruently within, the genome selected traits that play into its strengths (love/glory, hierarchy) and removes options unavailable to it (competition for monetary prizes). As a result of this assessment, the Digital Hive genome is presented as the predicted best way to structure and implement the website for optimal value production. The final determination would of course need to be further tested during follow on efforts.

V. CONCLUSION

A. SUMMARY OF DESIGN QUESTIONS

This capstone focused on developing a coping mechanism for information overload. Prior to designing a prototype website, this capstone questioned the historical alternatives for coping with information overload to validate why a website might be a better solution. The next question considered how a website should be designed and, more importantly, how users would use the website to produce value. To guide the development of the web portal, this capstone proposes a design challenge to answer how a website can best be designed to cope with the effects of information overload by improving knowledge sharing, collaboration between users, and informal networking.

B. SUMMARY OF FINDINGS

The summary of my findings is divided into two categories, general and implementation. The general section provides my findings on informal networking and the value it affords. The implementation findings touch on the technological insights for using a website tool to gain knowledge.

1. General Findings

a. People as Knowledge Resource

Initially, this project aimed to develop a better resource to navigate and retrieve knowledge. This aim had been in large part inspired by my own personal job experience as an EOD officer and the frustration caused by having to navigate to many different websites to acquire doctrine. The websites were often sluggish, required me to remember many different passwords and user names, and were not intuitive. After discussion with my peers, it became evident that they too harbored similar frustrations regarding knowledge procurement, but one peer expanded the discussion by adding that not only was it frustrating to have so many databases from which to pull knowledge, but that the knowledge within those databases was not being updated symmetrically to EOD threats—the knowledge was old. Other users on the VCP shed more light on the issue by

noting that not only was it difficult to acquire doctrine, but it was extremely difficult to search out other EOD operators in key positions. Members of the EOD profession, especially ones who had served as liaisons, repeatedly voiced their inability to seek out people in key positions over the course of the capstone. Due to the isolated nature of many EOD billets, members of the EOD community explained that their success more often than not was predicated on the ability to communicate with key individuals for solution development rather than doctrine. They explained that the former often guided them to the latter, but with much greater efficiency. Thus, a key finding for this capstone was the idea that people are becoming an increasingly valuable knowledge resource, and those who are most successful in the EOD profession have well established networks among people.

In the course of this capstone, the design thinking process yielded us even greater insight into the information overload issue at hand. One obvious problem that emerged was the realization that there is little sharing of knowledge and lessons learned between the agencies and EOD organizations identified in this capstone. One reason for this is that the organizations are not designed to be integrated with one another; they each have their own independent databases and knowledge management solutions. What this capstone discovered is that these organizations in the recent past did not have to share knowledge because the TTPs involved with EOD operations were standardized. Up until the wars in Iraq and Afghanistan, the means by which EOD operators and bomb technicians prosecuted explosive and other energetic threats were mostly fixed because the threats at that time were unanimously conventional. As a result, the organizations tasked with prosecuting explosive threats established doctrine and rigid systems for conducting EOD operations. At that time the hermetic nature of EOD organizations and agencies was inconsequential because they were performing their jobs effectively.

The biggest issue with EOD operations after September 11, 2001 is that the threats facing EOD operators in the field are no longer solely conventional. The great spike in IED activity during the last decade has led to a threat environment limited only by the imagination of bomb builders. The standard doctrine fails to account for emergent threats and so EOD organizations have scurried to update their knowledge processes to

keep pace with them. Unfortunately, the organizations are working independently in these efforts. But this pace is not sustainable by organizations working alone, and to some extent doctrine cannot be updated fast enough because of bureaucratic approval processes. What we learned through our discussions with multiple EOD operators is that people are the best knowledge resource in rapidly changing threat environments. We found that by gathering a large enough group of EOD operators and bomb technicians from different agencies and organizations, their collective experience is likely to cover down on every threat EOD operators are likely to face. Therefore, it is our finding that providing members of EOD organizations and agencies the ability to communicate their lessons learned and ideas, and actively seek each other out to develop future strategy and solutions, is the best way to augment knowledge management and procurement because it recognizes the rich tacit knowledge that diversified people have based on their first-hand experiences. This type of knowledge is best communicated through two-way communication whereby each side can ask for clarification or steer the dialogue into areas of deeper knowledge. Doctrine is limited in the sense that the reader cannot with ease communicate with the author to clarify ambiguities or present possible issues with the provided solution.

The solution we developed requires organizations and agencies to look at the bigger picture to identify and combine redundant systems and processes such that everyone can benefit. Examples abound that in web forums with such a large pool of potential participants (YouTube), surely there will be arguments and disagreements on prescribed solutions, and likely some horrible and even dangerous comments will be shared, but we found that groups are more than capable of policing their own. Within analogous web frameworks, trolls and other nefarious commenters quickly become ostracized by the group, and their comments lose credibility. One obvious deterrent for web hooliganism is mandating that users include their real name. While some users may feel disinclined to participate, the benefit is that when people do participate, they are quite literally staking their name and credibility on their ideas and comments. In my experience working on the VCP, having users introduce themselves and provide their motivations for joining led to a sense of camaraderie and support whereby other users

welcomed newer users as a sign of mutual respect for a noble cause. In the course of six months, not one instance of disrespect or nefarious action took place.

b. Increase Knowledge Flow

Regarding the knowledge management aspects of the U.S. EOD network, organizations tasked with providing knowledge become hubs of components, that is, they become central to disconnected EOD networks. They exist as components because of the authority ties that dictate their existence and roles within the bureaucracy. However, as bureaucratic institutions, they are inflexible and un-adaptive at providing up-to-date knowledge and training. Bureaucratic approval process is required before new knowledge can be supplied to the network. However, a lag emerges because until the time when new knowledge is disseminated, EOD operators are operating in the blind. The irony is that the knowledge institutions rely on data collected in the field. Thus, knowledge flow in the EOD community is hindered because it does not flow from the field back into the field directly; it must first go through the bureaucratic stovepipes for approval.

The GAO report cited earlier came to the conclusion that joint doctrine is required to right failures in joint capability, knowledge sharing, and use of EOD technicians in operations.[127] U.S. Navy Capt (Ret.) Jeffrey Trumbore, former Joint Improvised Explosive Device Defeat Organization (JIEDDO) Division Chief for Technology and Requirements Integration, echoed the same sentiments by stating, "EOD's challenge is to identify an appropriate way to provide a solid foundation for preserving these [learned] skills." He argues that joint doctrine is the answer, but will "require a long-term, sustained effort to influence the normal joint publication set five year review and revision cycle."[128] While I tend to agree to some extent that joint doctrine is necessary, it alone is not a sufficient condition to correct the design issues of the U.S. EOD network, and five years is entirely too long a hiatus to update TTPs and provide guidance to commanders

127 Government Accountability Office, *Explosive Ordnance Disposal*, 14.

128 Jeffrey Trumbore, "Combat Experience of Bomb-Disposal Teams Should Be Codified," *National Defense*, September 2013, http://www.nationaldefensemagazine.org/archive/2013/September/Pages/CombatExperienceofBomb-DisposalTeamsShouldBeCodified.aspx

operating within an unconventional environment that changes daily. Trumbore himself even admits "much of EOD's success in these complex battlefields came from learning on the fly and not from the application of existing doctrine."[129]

The evidence presented in this capstone suggests the better avenue of approach is to consider how *well* EOD operators learned "on the fly" during that time period and consider the possibility that it was precisely the absence of rigid doctrine that enabled EOD operators to interact and share with each other the TTPs that they were successfully innovating and executing. Identifying the elements that enabled EOD operators to learn from each other are key elements of success that must be leveraged, not ignored and replaced by the de facto solution of writing more doctrine. Learning on the fly is also another way of saying informal networking since both emphasize and value people as primary sources of knowledge. Unlike traditional doctrine, our solution proposes a more organic approach to knowledge management. We found that doctrine is necessary, but it should integrate people whereby commenters can isolate parts of doctrine in order to suggest ways to make it better. Keeping the comments open and transparent affords participants an opportunity to become part of the process and enrich the knowledge on given subjects.

2. Implementation Findings

a. Finding Accord between Administration and Operation

In order to re-align the U.S. EOD network as a whole, a proper harmony must be struck between the administrative and operational networks—each must recognize its strengths and weaknesses and adjust to better provide value for the *whole* network. With the vast amount of EOD organizations, there needs to be a committee of dedicated managers to promote and cultivate the health of the network as a whole. This capstone unfortunately did not focus enough on this aspect and is therefore unable to explicitly recommend how this should be done specifically. However, management for the whole network is something we discovered is absent but necessary to promote our technical solution. Without an overall management for the U.S. EOD network, components form

129 Ibid.

and sub-optimal processes occur due to organizations only performing for their own benefit and not for the network as a whole. This capstone offers one way to provide a singular framework that all EOD operational organizations can use to provide value for themselves. The administrative organizations can augment the U.S. EOD network by supporting this website initiative and better learn how to provide for the operators by listening to what they have to say.

b. Implement a User-Friendly Experience

This capstone found that another major consideration regarding implementation of a website solution is the degree to which simplicity, utility, and personalization are maximized. The disadvantage to developing a web portal solution is that users already rely on many web portals to in their jobs. Many of our users expressed dissatisfaction with current websites they are required to use, including the Combined Information Data Network Exchange (CIDNE), Defense Readiness Reporting System-Navy (DRRS-N), Readiness and Cost Reporting Program (RCRP) and Advanced Skills Management (ASM) system. Users identified these websites as un-intuitive, clunky, and ultimately of a design where value is created only for superiors in a hierarchy.

Our findings led us to the realization that providing users a portal in which they can intuitively navigate and retrieve knowledge increases the likelihood that they will return to it in the future. Additionally, by providing them with simple yet sophisticated tools, users are able to perform many different functions according to their unique needs. Thus, the utility of the website increases because it can be used for many different things—informal networking via the profile page, knowledge retrieval, the ability to post ideas and personal experiences, and the chance to communicate on topics of interest. As well, we found that users are often unaware of others who could be valuable network assets. By allowing users to follow topics they are interested in, they increase the likelihood that they will interact with other user, regardless of their background, based on similar interests. Thus, individuals are brought together based on their needs or interests regarding specific topics.

Similar to utility, our findings also found that enabling people to personalize their experience increases their desire to participate as well. Our solution affords personalization by allowing users to create a profile page in which to display a username and upload an avatar. Our findings suggest that people take pride in their personal accomplishments and are incentivized to participate in online discussions when peer recognition is available to them. In this way, users enjoy their experience and are rewarded for their efforts based on a system of peer recognition. Lastly, because our web solution enables people to interact directly to share knowledge and solve problems independently, they can create value for themselves at an incredibly fast pace.

C. RECOMMENDED FUTURE EFFORTS

This capstone provides a technical solution for the effective management of information overload. However, due to the limited scope, time, and resources available, this capstone does not address the political and administrative issues associated with the implementation of a web solution. Earlier in the capstone I stated that IHEODTD is the organization best suited to adopt the concepts developed for the prototype because they already have established SIPR security measures to afford authorized users access to AEODPS and other reach back features. However, I cannot state with certainty that the concepts developed by this capstone could be implemented on the JEOD portal without violating existing policies and procedures associated with SIPR websites.

This capstone likewise does not address bureaucratic processes and the likely possibility that the website solution is in competition with other solutions being proposed by invested individuals likely to thwart such an effort. Neither does this capstone address the cultural aspects that a website as this capstone champions requires to support it. Specifically, a leadership style that empowers subordinates by trusting their judgment is required to promote and cultivate a website in which distributed users create value for themselves. As members of hierarchical organizations work together to develop next-generation solutions, they must be encouraged to propose innovative solutions with an promise that those ideas will be taken seriously and valued. Communicating that promise is a task for leaders in those organizations.

The concepts espoused herein are also indicative of a disruptive technology. The website allows users to point out the inefficiencies and problems with the current formal processes. The knowledge procurement process is made more transparent and fluid. Some individuals, especially those in knowledge oversight positions, could potentially feel threatened by a technology that shares their power with a distributed collective. Humility is therefore a necessary ingredient in implementing this solution.

1. Formally Recognize the Value and Power of Distributive Information

To enhance the ability of the operational organizations to carry out the EOD mission, the administrative bureaucracy needs to protect and foster the emergence of informal ad hoc networks, such as this capstone affords. Anklam explains that within the complex environment—where EOD operations undoubtedly occur—"emergent and innovative networks thrive." [130] However, she adds that in order for those emergent networks to succeed, a "governance must be sufficient to provide infrastructure," but that the "value of the network comes from its vitality." [131] In other words, the bureaucracy should aid the operational network by formally providing a hive infrastructure from which the operational network can swarm to provide value for itself, informally. Currently, the system as a whole is incongruent to the extent that while it recognizes the need to afford operators in the field autonomy to conduct EOD operations, it retains almost complete authority over knowledge dissemination and procurement. Those conducting EOD operations are afforded great flexibility and adaptability to respond to threats, but the tenets of research and development are tightly controlled and bound to key individuals in those job positions—a major design tension for the U.S. EOD network. The disparity between those operating on a loose set of guidelines to defeat EOD threats is incongruent with the highly controlled and closed development of technology and TTPs to defeat the same threats.

130 Anklam, *Net Work*, 188.

131 Ibid.

2. Embrace Incomplete Knowledge Procurement

In the aims of this capstone, I contest that EOD TTPs should not be codified in a document because in doing so they become simultaneously complete and obsolete—once finalized it ceases to account for changes in the threat environment. Instead, what is required is an infrastructure for not only sharing knowledge, but for recycling and updating it. An incomplete system is required in the sense that it must never become static within a constantly evolving complex threat environment.

A highly interactive forum needs to be cultivated to develop TTPs that are purposively incomplete such that they can scale and flex in response to *any* emerging threat. Where doctrine is by definition a one-sided, consume-only infrastructure, an interactive and participative forum in contrast allows users to contribute and enrich knowledge, not just consume it. This capstone promises a two-way means of communication that incompletely codifies TTPs, thereby allowing the EOD force to remain on the cutting edge of modern warfare. As such, this type of infrastructure has human beings on both the front end and back end of the infrastructure, and it is much more robust and flexible than the bureaucracy that must enable it. An interactive forum, unlike a completed document, is an organic system that interacts with users to improve efficiency and value output.

3. Lessons in Cultivating a Distributive Network

In the course of this work, I had the unique experience of cultivating an online community from which to exact the design thinking process. Initially, I attended the Naval C-IED Knowledge Network (NCKN) in Dahlgren, VA, which is an interagency and organization meeting among EOD stakeholders. At that meeting, I introduced the aims of the capstone and passed out a point paper, inviting attendees to join the project and participate as designers. Following the meeting, I retained permission to e-mail the point paper to the NCKN distribution list of over 800 people.

Within the first day, I had roughly 10 requests to join the Google+ website community and 20 emails. Most of the communication I had with people at the early stages of the project involved personal accounts of instances in which they experienced

information overload followed by encouragement to keep up the good work. When asked if they would like to participate, most declined or failed to respond to my request all together.

Initially, I populated the website with academic articles related to my capstone and design thinking manuals. However, it quickly became evident that members of the community were not interested in poring through pages of academic works. Therefore, I changed tactics and tried to make the website more user friendly. Using Google docs, I created several picture-heavy power points to depict the intent of the project and a brief introduction to design thinking. I also created a tab whereby users could navigate to a separate page that I linked several technology, entertainment, and design (TED) videos, including several by Clay Shirky, who has been heavily cited in this capstone write up. Adding power points and videos greatly helped to increase participation on the website, notably because I later learned that most individuals operating on government networks were denied access to Google+. Most users accessed the Google+ website during non-work hours.

Perhaps the most successful thing I incorporated into the community was an "introduce yourself" tab. As members requested access to the community, I asked them to navigate to that tab and write a short description of who they are and what motivated them to become a part of the project. That page quickly bloomed into an active element of the page because not only did members write remarkably insightful comments regarding the frustrations with information overload, but also other users began replying to those comments in a dialogue. The diversity of participants also generated discussions whereby individuals began asking other users more about their background and the capabilities of their organization to perform certain EOD functions they were unaware of.

Over the course of the capstone, 101 members joined the community. Of the 101 members who joined, only three participated regularly in the core design team. An interesting fact to point out is that these most active members were not EOD technicians, but considered themselves stakeholders because they had worked closely with EOD members in C-IED efforts. These individuals were also retired military and presumably had more time available.

Another challenge was to conduct video conference calls. While the use of Cacoo afforded us tremendous tools to augment the design process and enable us to share a virtual creative space, it nevertheless had its own challenges. Members often did not log into the call at the scheduled start time. Therefore, sometimes half way through a design session, members would join the call, making it disruptive to the process. As well, several times individuals had technical issues or had difficulty installing the Cacoo software. As a result, early on some design sessions were entirely consumed with troubleshooting one member's technical issues.

The greatest lesson I learned regarding the use of an online collaborative environment to conduct a design thinking challenge is there needs to be an allotment of time for participation. The greatest deterrent I had soliciting EOD technician involvement was the fact that the individuals I most desired to participate were too busy to provide their time consistently. There was also a lot of trepidation on the part of EOD stakeholders to participate in developing anything that was targeting implementation on the SIPRNet. While I know that until content is introduced into the website prototype it remains unclassified, many users were wary of the fact and preferred to distance themselves from the project. I believe that had I gained buy-in from leaders in EOD organizations and agencies who could have assuaged the fears of individuals to participate, I would have had more substantive interactions. Gaining buy-in of leaders might also have yielded situations in which individuals in these agencies and organizations could have been allowed to participate in sanctioned working groups to participate.

4. Future Efforts of this Capstone

This capstone offers an example of how to network the U.S. EOD community and simultaneously influence its retention of agile and flexible operation. As a prototype of such an ad hoc networking tool, this capstone nevertheless demonstrates the value of allowing users to organize and order themselves towards the common goal of enriching EOD knowledge and developing innovative solutions to thorny and wicked problems affecting EOD organization. However, this capstone should by no means be considered

the ideal solution. The design process is an iterative and ongoing process by which artifacts are developed to augment our daily lives and our jobs. As such, this capstone did not afford an ample amount of time or manpower towards the creation of a final product.

As with any change in existing infrastructure, it must be implemented carefully and incrementally. It would be disastrous and counterproductive to implement a website with all of the features espoused in this project. Rather, a gradual and well-considered execution must be exacted such that by degrees certain elements can be tried and observed. Additionally, these amendments to infrastructure must be carefully tested prior to being adopted as any glitches or malfunctions associated with these recommended eventual changes might act as a deterrent for the very users whose job experience we are aiming at improving.

To further this capstone, I recommend a future study to be conducted at a reputable EOD knowledge institution. IHEODTD would be my first stop as they already provide the largest database of EOD information, AEODPS, on the SIPRnet. To ensure stakeholder support, I advise inviting all U.S. EOD operational organizations to provide input and personnel to participate in design workshops. Outside facilitators and project managers inculcated in the design process would be extremely useful at steering these groups to the constructive advent of improved prototypes.

Development of this website must not be conducted by isolated IT personnel. Rather, it must be an integrated and interactive process combining high level EOD leadership, capable computer programmers, and uninhibited EOD technicians dedicated to improving information overload and its detriment to the EOD mission.

Lastly, the project itself must be afforded support both from high level leadership and culturally from within the EOD force. As such, leaders at all levels have a responsibility to educate their subordinates on the value of this initiative and explain how it affects them directly. This project should be developed at all levels and with the following motto in mind: developed for EOD operators by EOD operators.

D. GREATER IMPLICATIONS

On one hand this capstone has produced a website for a particular subset of the military and select government agencies. It has presented a prototype and analyzed how it can benefit the U.S. EOD community and help foster a community of practice. However, in many ways, of greater importance for this capstone is not the deliverable but the process by which it was developed. In today's military, problems are likely to become increasingly more complex and convoluted. Decision making and problem solving for future military leaders therefore requires a unique set of skills and processes. Today's complex military environment, where decisions need to be made quickly, requires more group coordination, networking, and capable facilitation than ever before to deliver robust solutions. The design process used in this capstone project is one such skill set that holds great promise, if not necessity, for future solution development. This capstone can therefore be a model by which similar prototypes can be developed throughout the military and government to produce innovative solutions and coping mechanisms.

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APPENDIX A. PROTOTYPE TEST RESULTS

Participating users were briefed to pretend they were isolated EOD officers acting as liaison officers (LNOs) at USAFRICOM. A flash message comes through regarding a possible EOD mission in the Gulf of Aden to respond to a Somali sailboat full of questionable ordnance as well as intelligence suggesting affiliation with IED networks in Al Shabab. The user is directed to use the EOD Digital Hive website to form an ad hoc EOD knowledge network to aid in decision making and enable him to make proper advisement to superiors.

Below is a comprehensive list of the tasks our users performed in pursuit of their mock goal. The tasks we chose represent an exhaustive account of the features of the hive website. Users were not given any instruction on how the website works. The results below are those achieved by the users on their first encounter with the website and were done so intuitively.

Table 1. User prototype test.

	USER 1: 28yrs	**USER 2: 30yrs**	**USER 3: 31yrs**	**avg / efficiency**
1.) Check your alerts.	3.1s	4.3s	10.1s	5.8s / 100%
2.) How many alerts do you have?	1.3s	.85s	.93s	1.0s / 100%
3.) Post a comment.	6.3s	7.3s	2.3s	5.3s / 100%
4.) Request alerts for Surface and IED categories.	5.8s	7.3s	8.1s	7.1s / 100%
5.) Navigate to Get / Share Knowledge.	2.4s	3.1s	2.7s	2.7s / 100%
6.) Navigate to IED category	.95s	.91s	1.4s	1.1s / 100%

	USER 1: 28yrs	**USER 2: 30yrs**	**USER 3: 31yrs**	**avg / efficiency**
7.) Navigate from here to IED activity in Somalia. This is a multi-step process, see if you can do it.	7.3s	5.1s	11.8s	8.1s / 100%
8.) Explain in your own words the purpose of the different colored hexagons?	PASS	PASS	PASS	N/A / 100%
9.) What does a triangle in the middle of the hexagon denote?	PASS	PASS	PASS	N/A / 100%
10.) Navigate to the video question that has 8 posts and a total of 148 +1 votes.	3.4s	5.4s	5.1s	4.6s / 100%
11.) On this page, identify the original post.	4.0s	7.3s	8.1s	6.4s / 100%
12.) Play the video associated with the original post.	11.9s	5.1s	15.9s	11.0s / 100%
13.) Demonstrate how you would reply to the 'disagreement' post.	2.7s	4.1s	2.1s	2.9s / 100%
14.) Demonstrate how you would ask a question directed toward the 'disagreement' post.	6.3s	5.4s	5.7s	5.8s / 100%
15.) Place your mouse where you would imagine your post would show up.	PASS	PASS	PASS	N/A / 100%
16.) Send EOD_Guy25 a friend request.	3.2s	2.1s	5.7s	3.7s / 100%
17.) Send EOD_Guy25 a message.	.83s	.92s	1.7s	1.15s / 100%
18.) With only one click, navigate to the USAFRICOM topics page.	7.3s	4.1s	9.3s	6.9s / 100%

APPENDIX B. USER FEEDBACK

Below is the user feedback form we gave to our users. The purpose of the form is to provide background information on what type of users we had testing our prototype. The goal is not to stereotype a certain type of user, but rather to gauge how well our prototype performs for a wide range of potential users.

Table 2. Prototype feedback form

	USER 1	**USER 2**	**USER 3**
1.) Please provide the following information: Age: Sex (M/F): Service/Agency: Rank: Years in EOD: Do you currently have a facebook account? Do you currently have a twitter account? How many hours a week would you say you spend using social media? Do you now, or have you ever, used social media for work-related purposes?	 28 M USN EOD O-3 7 YES NO 1 YES	 30 M USN EOD O-3 7 YES YES 1 YES	 31 M USN EOD O-3 10 YES NO 3 YES
2.) On a scale from 1 to 5 (5 being the best) how easy was it for you to navigate on the profile page?	5	5	5
3.) Can you provide any feedback on the colors used on the profile? Were they distracting? Pleasing to the eye?	Too many colors for the category page	Color coding on posts page is easy to understand	No comment
4.) Was there anything about the profile page that you did not like or would you recommend any changes / additions to how it is currently set up?	No changes	No changes	No changes
5.) On a scale from 1 to 5 (5 being the	5	5	5

	USER 1	**USER 2**	**USER 3**
best) how easy was it for you to navigate on the get / share knowledge page?			
6.) Did you have any problems understanding the 'mind mapping' menu (this was the display with EOD in the center and the topics comprising EOD on the outside)? If so, what were they?	No problems	No problems	No problems
7.) Can you provide any feedback on the colors used on this page? Were they distracting / pleasing to the eye?	Too many colors	No legend	Distracting, not required
8.) On a scale from 1 to 5 (5 being the best) how easy was it for you to navigate on the 'base-layer' page? (This was the page where user's threads first appeared)	5	5	4
9.) How easy was it for you to make sense of the color-coding scheme, picture / video icons, and voting parameters?	Simple	Intuitive	Very Easy because of legend
10.) On a scale from 1 to 5 (5 being the best) how easy was it for you to navigate on the 'posts' page? (This was the page after the 'base-layer' page)	5	5	5
11.) How easy was it for you to make sense of the color coding scheme and synapses?	simple, arrows make it easy to follow	very easy	very easy
12.) Do you feel this provides better usability than a list of comments, ie YouTube format.	Yes, can visually see the type of comments and follow the thoughts	Yes, makes it easier to process it all	Yes, and the filters make it easy to funnel the data
13.) If this prototype were to go live in the near future, would you use it? If so, what would you primarily use it for? If not, would you please explain why?	Yes, points of contact	Yes, networking and knowledge retrieval	Yes, for finding people easily and getting their contact info
14.) Please provide any final comments or	No comment	Promising	Looks good.

	USER 1	**USER 2**	**USER 3**
feedback that you feel would be helpful in improving this prototype.		concept, make sure it stays intuitive	

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